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AGRICULTURE AND MECHANIC COLLEGE LIBRARY MAY 6 1954 MANHATTAN KANSAS

Pituophis melanoleucus ruthveni in Eastern Texas And Its Bearing on the Status of P. catenifer

By Hobart M. Smith and J. P. Kennedy

On June 2, 1951, the junior author secured an adult female Pine Snake (Fig. 1) sunning itself at the side of a small, sandy road 21 miles southeast of Livingston, Polk Co., Texas. The area is characterized by its predominantly sandy soil and the forests of long-leaf pine with mixed hardwoods.

This specimen, still alive in the collection of the junior author at the present writing (June, 1951), measures approximately 1500 mm. in total length, the tail 200 mm. Other characters are: length of rostral 1 1/2 times width; no azygous prefrontal; 4 prefrontals; supralabials 8-8, 4th entering eye; infralabials 12-13; preoculars 1-1; postoculars 3-3; loreal 1-1, small; scale rows 27-29-19, five rows smooth on each side anteriorly, one posteriorly; ventrals 213; caudals 59; spots on body 37, on tail 9; median (and to a lesser extent the anterior) blotches subdivided (as in Stull, Bull. U. S. Nat. Mus. no 175, 1940, p. 75, fig. 41a); blotches very dark brown anteriorly, lighter and more reddish (chocolate brown) on posterior two-thirds; lateral blotches more reddish especially on tail; ground color very pale brown anteriorly, becoming lighter posteriorly; head mostly dark brown, irregularly mottled above; both upper and lower labials barred; every temporal and nuchal scale with both dark and light areas.

Reference of this individual to *P. m. ruthveni* rather than to *P. catenifer sayi* (Schlegel) whose range Stull (*op. cit.*, p. 132, fig. 63) depicts as reaching extreme eastern Texas (and as accepted by Klauber Bull. Zool. Soc. San Diego, no. 22, 1947, p. 6, fig. 1) is assured by at least one objective character: the minimum scale row count in front of anus is 19, whereas 21 is the minimum known for *P. c. sayi* (*fide* Stull). Other subjective differences exist in the coloration and pattern. The number of ventrals likewise supports this allocation, for the minimum in *P. c. sayi* (*fide* Stull) is 212, only one less than in the present specimen, whose species attains a minimum of 205 (in *P. m. melanoleucus*). The character upon which Stull places greatest weight in distinguishing these two forms (cf. Stull, *op. cit.*, p. 76) is, however, the shape of rostral. That difference does not, unfortunately, apply to the present specimen. The rostral is shaped precisely like that of typical *P. c. sayi* with specimens of which direct comparisons have been made. As stated by Stull (*op. cit.*, p. 76), no differences exist in number of blotches.

Two other Texan specimens almost certainly referable to this species have been recorded, one by Burt (Journ. Washington Acad. Sci., vol. 25, 1935, p. 381;

specimen properly referred to *P. m. ruthveni*) from Zavalla, Angelina Co., the other by Brown (Check List Rept. Amph. Texas, 1950, p. 176; questioned reference to *P. c. sayi*), from Nacogdoches Co. Stull (*op. cit.*, p. 76) rejected Burt's record, referring the specimen to *P. c. sayi*; Brown's hesitancy to place his specimen with *P. m. ruthveni* no doubt arose at least in part from Stull's action. We regard both these literature records as referable to *P. m. ruthveni* chiefly on geographic grounds, but partly on the basis also of the great similarity of the two forms and Burt's rejection of one individual as *P. c. sayi*.

Stull's (*op. cit.*, pp. 106, 107) and Brown's (*op. cit.* pp. 175-176) detailed lists of Texan localities indicate that the range of *P. c. sayi* does not enter the eastern third of the state; the easternmost records are for Dallas, Ellis, McLennan, Williamson, Bexar, Victoria and Aransas counties (in order from north to south). There is a gap of some 135 miles between the nearest verified records of *P. c. sayi* and of the eastern cluster of three records for Nacogdoches, Angelina and Polk counties. Only on the basis of Burt's record could Stull project the range of *P. c. sayi* east of the 97th meridian. *P. c. sayi* apparently is restricted to more open, prairie areas of reduced rainfall. *P. m. ruthveni*, on the other hand, occurs in pine-covered areas of relatively high rainfall throughout its range.

The present records extend the known range limits of *P. c. ruthveni* approximately 125 miles from the type locality in central Louisiana (Longleaf, Rapides Parish). Another record of "Bull snakes" for Hodge, Jackson Parish, Louisiana (Clark, Journ. Tenn. Acad. Sci., vol. 24, 1949, p. 251) is probably referable to this race, which proves to have a much wider range than heretofore accepted. The general habitat is the same throughout the territory occupied and much different from that of *P. c. sayi*.

The question of relationship between *P. catenifer* and *P. melanoleucus*, *via* the adjacent forms *P. c. sayi* and *P. m. ruthveni*, received consideration first by Burt (*loc. cit.*), who suggested that intergradation may occur. Klauber and Brown (*loc. cit.*), have noted the possibility, but have accepted Stull's arrangement.

Apparently Stull was chiefly influenced by a presumed difference in shape of rostral in regarding *sayi* and *ruthveni* as representatives of different species. A statement in the original description of *P. m. ruthveni*, however, indicates that at least at one time she was aware of a resemblance not later pointed out. She there states (Occ. Papers Mus. Zool. Univ. Michigan, no. 205, 1929, p. 3): "This form is morphologically as well as geographically intermediate between *P. sayi sayi* and the more eastern subspecies of *P. melanoleucus*, and is nearer to *P. s. sayi* in the number of scale rows, shape of the rostral, and proportionate tail length than are other subspecies of *melanoleucus*." This statement suggests that the types, like the present individual, have a rostral little different from that of *P. c. sayi*. There may well be, of course, a trend within this race as there is in the genus, for the rostral to become wider toward the west.

The number of scale rows, which clearly places the present individual with *P. m. ruthveni*, does not serve to distinguish the two races, for the two types have 31-33-25 and 31-31-22 scale rows. The low number of ventrals which also aids elimination of *P. c. sayi* from consideration in connection with the present specimen likewise is of little racial significance, for the two types possess 219 and 218 ventrals, well within the range of variation of *P. c. sayi* (212-244). Accordingly the sole differences remaining between these two forms concern the color of the head and the dorsal blotches. In *P. m. ruthveni* the head is mostly dark, there is no well-defined postocular light stripe, and the dorsal blotches are not light-centered but are, at least on part of body, partially divided. In *P. c. sayi* the dorsal spots are apparently never divided and are usually light-centered and

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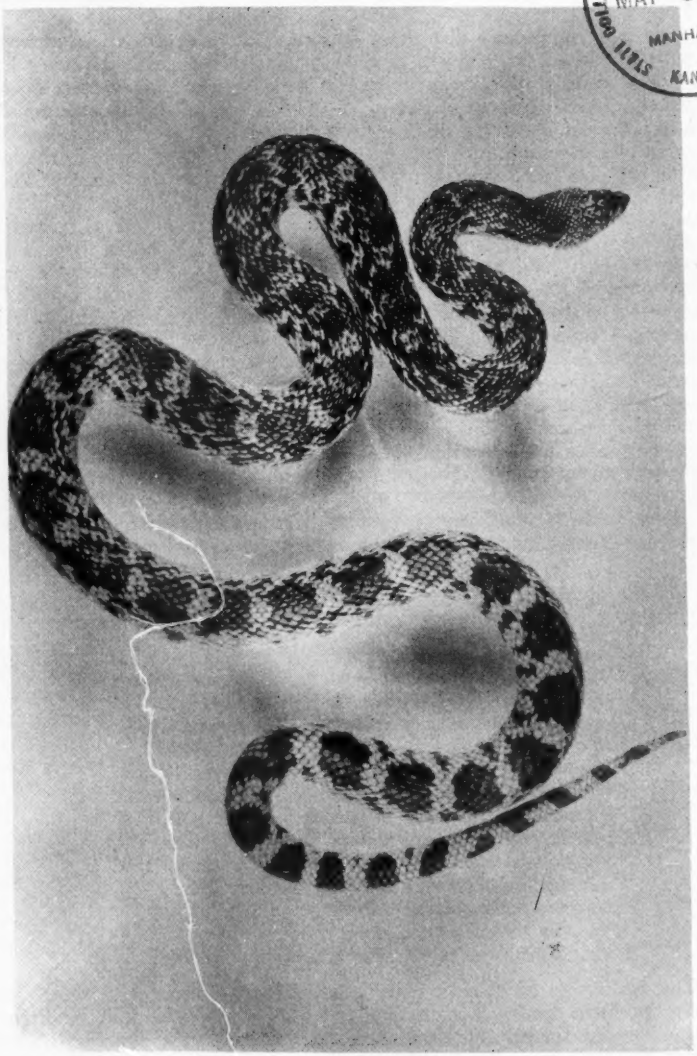

Figure 1. *Pituophis melanoleucus ruthveni.*

dark-edged; the head is mostly light, and a postocular light stripe to angle of jaws is usually visible. The slightly reddish tendency of *P. m. ruthveni* is not seen in *P. c. sayi*. No tangible difference in ground color or spacing of blotches is evident.

The most dependable distinctive feature of *P. m. ruthveni* is apparently its partially divided dorsal blotches. Yet this character even with the other less constant ones scarcely justifies retaining the forms in separate species. To be sure, there is an apparent hiatus in range, but only of about 135 miles as now known. It does not seem likely that this area is actually unoccupied by these snakes. It is true that all known localities in bothTexas and Louisiana fall within the long-leaf pine or oak-pine belts, whereas the eastern boundary of the range of *P. c. sayi* coincides more or less with the prairie grassland. Between lies an oak-hickory belt in which neither form has been recorded. This belt may act as a barrier, for certain parts (as for example the vicinity of College Station, Brazos County, Texas) certainly have been thoroughly explored without revealing the existence of any form of *Pituophis*. Contact of range farther south is still less likely. The most probable area of contact, if any exists, lies between the Trinity River at Anderson, Henderson and Kaufman counties and the Sulphur Fork River at Delta county. In that area the oak-hickory belt is relatively narrow, and may be penetrated sufficiently from both sides by conditions satisfactory for existence of both forms, to permit contact of range. The soils of the oak-hickory belt are essentially the same as those of the oak-pine and long-leaf pine belts, and thus should not constitute a barrier at least to the eastern race. The region is too poorly known herpetologically to warrent assumption that either form does not exist.

If, as seems highly probable, contact of ranges does occur the morphological differences observed certainly do not suggest that interbreeding would fail to occur.

We therefore propose that the pine snakes and bull snakes be regarded as belonging to a single species, whose forms may be listed as follows:

Pituophis melanoleucus affinis Stejneger 1893
Pituophis melanoleucus annectens Baird and Girard 1853
Pituophis melanoleucus bimaris Klauber 1946
Pituophis melanoleucus catenifer (Blainville) 1835
Pituophis melanoleucus coronalis Klauber 1946
Pituophis melanoleucus deserticola Stejneger 1893
Pituophis melanoleucus fuliginatus Klauber 1946
Pituophis melanoleucus insulanus Klauber 1946
Pituophis melanoleucus lodingi Blanchard 1924
Pituophis melanoleucus melanoleucus (Daudin) 1803
Pituophis melanoleucus mugitus Barbour 1921
Pituophis melanoleucus ruthveni Stull 1929
Pituophis melanoleucus sayi (Schlegel) 1837
Pituophis melanoleucus vertebralis Blainville 1835

The conclusion of conspecificity of the forms formerly regarded as constituting the two species *P. catenifer* and *P. melanoleucus* still requires final confirmation by further exploration in the critical areas described. Evidence now available, however, leaves relatively little to be assumed and its dirction is incontrovertible.

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The Distribution of the Gila Monster in New Mexico

By William J. Koster

Van Denburgh (1924), in his summary of the herpetological fauna of New Mexico, called attention to the lack of specific records of the Gila monster from the state and, until very recently, it has been the general practice to exclude New Mexico from the range of that animal. Two sets of evidence are now available, however, to show that *Heloderma suspectum* is indigenous to the Land of Enchantment. These are:

(a) During the meetings of the Southwestern Division of the American Association for the Advancement of Science, held in Flagstaff in the spring of 1950, I presented data indicating that the Gila monster is fairly common in some parts of the state, namely, in western Grant and Hidalgo Counties, and that it probably occurs some distance farther to the east. Reliable reports given to me by persons attending the meeting now make it possible to extend the known range as far east as Dona Ana County in south-central New Mexico.

(b) Shaw published a paper entitled "The Gila Monster in New Mexico," in the issue of Herpetologica dated June 5, 1950. This contribution contains information about two specimens collected in the state and mentions localities for several others, these based chiefly upon correspondence accumulated by Weldon D. Woodson, who is engaged in a general study of the Gila monster.

Since all my own records have been accrued from sources other than those published, I present them herewith, chronologically and in two groups: first, those accompanied by specimens and, second, those without specimens, but supported in other ways.

Four actual specimens have come to my attention. The first was excavated in early September, 1938, in the flat bottomlands at the edge of Albuquerque, Bernalillo County, by Mrs. Lela R. Koster and Mr. Portz Bretney who investigated a report to the effect that a Gila monster was frequently seen near the mouth of a particular burrow. The sandy loam soil of the area supported scattered clumps of alkali sacaton, *Sporobolus airoides*, and chamiso, *Atriplex canescens*. The elevation is approximately 4,960 feet. This individual and the next are preserved at the University of New Mexico. The second specimen was taken in Hidalgo County not far east of the Arizona border on the lower southwest slope of Cienega Peak at an elevation of slightly more than 4,000 feet on April 30, 1945, by Dr. Alton A. Lindsey. Dr. Lindsey reported the area to be of the general desert grassland vegetation type which, because of slope and exposure, leaned strongly toward the yucca-cactus association. The dominant plants in the vicinity of the point of capture were, in order of decreasing abundance, creosote bush (*Larrea tridentata*), ocotillo (*Fouquieria splendens*), and palmilla (*Yucca elata*). The third specimen was caught on August 4, 1948, near the chicken house at the McGee mine about 21 miles southwest of Lordsburg, Hidalgo County, by Donald A. McGee. He presented it to Barney L. Gardner who, in turn, sent it to the Philadelphia Zoological Garden where it is now on exhibition. According to Mr. Gardner, the mine is at an elevation of approximately 4,500 feet in a volcanic region where the dominant vegetation consists of two types of yuccas. McGee is said to have seen four other Gila monsters in the vicinity of the mine during his residence there. The fourth specimen was taken September 16, 1950, fifteen miles northwest of Lordsburg, by Barney L. Gardner. This Gila monster is also now alive at the Philadelphia Zoo.

The following records are not accompanied by specimens and, admittedly, are of less value than the preceding in delimiting the natural range of the species. Only those records considered to be reliable are included here. Records received second hand are omitted because of the difficulty of judging the accuracy of the identifications. Collared lizards, *Crotaphytus collaris* (Stejneger), are not infrequently identified as Gila monsters by laymen.

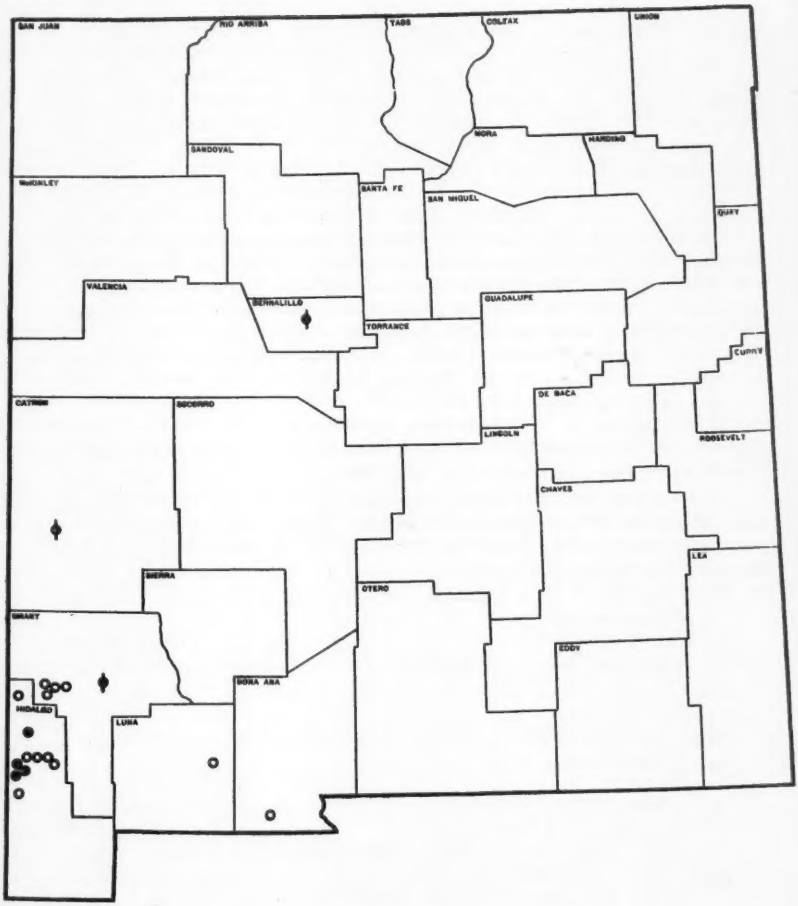
The earliest record is contributed by Mrs. Imogene Brooks, of Santa Fe, New Mexico, who writes that she saw a Gila monster sixteen miles east of Deming, in Luna County, either in 1917 or 1918. Professor Frank Hibben, of the University of New Mexico, recalls seeing a Gila monster about five miles east of Steins during May, 1934. Steins is situated in Hidalgo County, close to the Arizona border and not far from the McGee mine. A record from farther north is provided by Major Sam W. Bowman who reported seeing a Gila monster, in 1935, in Catron County approximately four miles north and east of Reserve. Aided by a Faculty Research Grant from the Uuniversity of New Mexico, I have collected, near Reserve, probably not far from where Major Bowman saw his animal. Except for the irrigated agricultural areas in the main canyon, the region is a woodland with a rather well-developed stand of alligator bark junipers (*Juniperus pachyphloea*), oaks (*Quercus sp.*), and walnut (*Juglans rupestris*).

Mr. Conrad Naegle, formerly an instructor of the University of New Mexico, stated that he saw Gila monsters in the vicinity of each of the three places in which he spent his youth: Redrock, in Grant County; Virden, in Hidalgo County (both in New Mexico); and Duncan, in Greenlee County, Arizona. Virden is almost on the Arizona border, approximately twenty miles down the Gila River from Redrock. Duncan is just across the boundary from Virden.

Another set of records comes from C. W. Bennett, Engineer for the Soil Conservation Service, who in May, 1935, captured two Gila monsters, approximately a mile apart in L. C. Canyon, about four miles northwest of Redrock. One of these individuals was photographed and, after a short period in captivity, the pair was released in Arizona! The photograph has been examined and it is undoubtedly that of a Gila monster. According to Mr. Bennett, the dominant vegetation in the region of capture consists of dwarf oaks and junipers.

In 1938, Dr. M. G. Anderson, of the Biology Department of the New Mexico A. & M. College, saw a Gila monster at Aden Crater, which is located in southwestern Dona Ana County, approximately sixteen miles southwest of Afton. According to Dr. Anderson, the crater is the remnant of a volcanic cone surrounded by a lava flow that is covered with sparse desert vegetation. Dr. Robert A. Nichols, also of the New Mexico A. & M. College Biology Department, and his son saw a Gila monster at the same locality on May 14, 1949.

Still another pair of Gila monsters from Redrock was captured on August 12, 1949, by the Mr. Gardner who has sent specimens to the Philadelphia Zoo. Unfortunately, these two lizards were loaned to a resident of Redrock who has since allowed them to escape. Mr. Gardner writes that the pair was taken about one half mile east of the town in the cultivated river-bottom lands. During the summer of 1949, a graduate student and I spent portions of two days collecting vertebrates, chiefly fishes, in the vicinity of Redrock. Other than the level lands bordering the Gila River, which are mostly cultivated, the area is one of desert grasslands with local stands of palmilla, mesquite (*Prosopsis juliflora*), and creosote bush, and with dwarf oaks in some of the draws. An altimeter reading at the river, not far from the point of capture of Mr. Gardner's specimens, indicated an altitude of 3,900 feet.



Map showing the distribution of the Gila monster in New Mexico. Localities represented by specimens, either preserved or in captivity, are marked with closed circles. Localities not represented by specimens in collections are marked with open circles. A bar superimposed upon the circle indicates that the individual in question is probably not indigenous to the area.

A major problem encountered in modern attempts to delimit the natural range of a species is that of recognizing man-caused extensions. The difficulty is intensified as one approaches the natural limit of the range. This problem, which has assumed such great proportions in a study of the fishes of the state, due to the activities of fish culturists and bait fishermen, is also present in studying such reptiles as the Gila monster, box turtle, horned toads, and rattlesnakes. These animals, because of their value as pets or curiosities, after being collected, are frequently lost or liberated elsewhere. The Gila monster is commonly kept in roadside zoos and, unquestionably, sometimes manages to escape. On the other hand, as Smith (1946) has pointed out, the persistent persecution to which the Gila monster is subjected would tend to restrict its range. In this connection, herpetologists will be pleased to learn that the Arizona Game and Fish Department has placed the Gila monster on the list of protected animals largely due to the efforts of Dr. H. L. Stahnke of Arizona State Teacher's College at Tempe.

Among the records I have accumulated, some are probably the result of man's activities. The Albuquerque specimen doubtless belongs in that category because it is well outside of the known range and habitat and because considerable field work in the region has failed to produce a second record; further, investigations made immediately after capture disclosed that a carnival had been in the immediate vicinity a few weeks before. The record from Reserve probably also represents an escaped individual. Major Bowman knows the Gila monster, and yet the habitat is very different from that usually associated with the animal. Assuming the identifications of the remaining individuals to be correct, they may well represent native individuals since they were taken in localities and under circumstances where one might expect to find them.

The records for *Heloderma suspectum* in New Mexico published by Shaw (*op. cit.*) plus those which I have accumulated and believe to be authentic are summarized below. Localities marked with an asterisk are represented by preserved or captive specimens.

BERNALILLO COUNTY:
- Albuquerque*

CATRON COUNTY:
- 4 miles N. and E. of Reserve

DONA ANA COUNTY:
- Aden Crater

GRANT COUNTY:
- Silver City*
- Redrock
- 4 miles NW of Redrock
- 1/2 mile E. of Redrock
- 2 miles down the Gila River from Redrock

HIDALGO COUNTY:
- Lower SW slope of Cienega Peak*
- 21 miles SW of Lordsburg*
- 15 miles NW of Lordsburg*
- 6 miles SW of Steins*
- Steins
- 5 miles E. of Steins
- 8 miles E. of Steins
- Pyramid Mountains
- Road Forks
- Virden

LUNA COUNTY:
16 miles E. of Deming

It will be noted that a number of these records are clustered about the towns of Redrock and Steins.

From the above it may be concluded that the Gila monster is fairly widespread through the four southwesternmost counties of New Mexico. The habitat data, where available, indicate that the animal is more likely to be found in rough desert shrub areas than in the grassy plains. Except for the two records that are believed to be of escaped individuals and the Silver City record, all the localities would be included in the Lower Sonoran Life Zone as outlined by Bailey (1913). Shaw (*op. cit.*) has suggested that the Silver City record may represent a shipping point rather than a collecting station. This is probably correct.

Words of thanks must be expressed to all the persons mentioned above who have supplied records and specimens. I am also especially indebted to Roger Conant, of the Philadelphia Zoological Garden, who has been most cooperative and who, upon hearing of my interest in New Mexico records for *Heloderma*, generously presented me with all his data and correspondence on the subject—even though he had contemplated publishing upon it himself.

MAY 6 1954
MANHATTAN KANSAS

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—University of New Mexico, Albuquerque, N. M.

SAUROPHAGOUS BOX TURTLE—Theodore Eaton has reported (1947, Copeia, Part 4:270) a *Terrapene ornata* as attacking and eating an adult *Phrynosoma cornutum*. Pope (1946, Turtles of the United States and Canada. p. 143) mentions *Terrapene ornata* as attacking and consuming a six-lined racerunner lizard. However, he makes no mention of any other species of *Terrapene* as preying on a vertebrate.

While watering a cage of assorted lizards, a small female *Anolis carolinensis* leaped out and ran into an adjacent cage containing a small *Terrapene carolina* (4 1/2 inch carapace) that had been collected in New Jersey. Some fifteen minutes later, the turtle was found to have grasped the Anole immediately anterior to the right hind leg. It held the lizard down with its forefeet while consuming it. The entire animal with the exception of the tail and the legs, was eaten.

—J. M. Mehrtens, C. F. Herrmann, 74 Eldert St., New York City

The Food of Rana catesbeiana Show in Puerto Rico

By Mario E. Perez

The common bullfrog *Rana catesbeiana* Shaw of southeastern United States was introduced into Puerto Rico in 1935 by the Insular Department of Agriculture and Commerce. Mr. Adger C. Smyth, head of the Ornithology and Pisciculture Service, notes in the 1935 Annual Report that a total of forty frogs from Florida were placed in a specially constructed pond at Rio Piedras. In the 1936 Annual Report he stated that the introduction and breeding of the bullfrog in Puerto Rico had been very successful.

The present range of the bullfrog on the island is not known exactly but may be expanding rapidly in the more humid coastal areas. The frog is at present definitely known to be in the evirons of Rio Piedras and neighboring towns, and at Mayaguez and Humacao. Most recently it was reported from Barceloneta, where it caused a great deal of nervousness among the inhabitants who had never before heard the call of the male frog. So many stories and superstitions were current about these nocturnal sounds that the Station had to explain their cause in the newspapers. Similar apprehension occurred some ten years ago in the vicinity of Rio Piedras but on that occasion a continental lady, Miss Asca Watson, who probably had heard the bullfrog's croak many times in the States, cleared the mystery.

The leading crop in the island of Puerto Rico is sugar-cane, the cultivation and processing of which employs around forty percent of the island population.

Excluding the sugar-cane mosaic disease prevalent about 1915-1920, the most serious threat to the sugar-cane industry has been the white grubs of the genus *Phyllophaga*. They attack not only sugar-cane but almost every other crop grown. Mr. Harold E. Box, Entomologist of Central Aguirre (1925), indicated the seriousness of the situation when he noted that "the administration of one of the largest concerns operating in the south coast of Puerto Rico spent approximately $15,000 upon six million grubs and 4 million adults of *Phyllophaga* during five years 1919-1923 inclusive, in hand collection control."

The situation finally became so critical that with the purpose of finding a remedy for this pest the Sugar Producers' Association of Puerto Rico founded the Experiment Station now at Rio Piedras.

Mr. D. W. May, Director of the Federal Experiment Station at Mayaguez, introduced a few toads, *Bufo marinus* (Linnaeus), from Barbados in 1920. In 1923 Mr. R. Menendez Ramos, Director of the Insular Experiment Station, released at Rio Piedras other individuals of the same species from Jamaica.

The studies by Mrs. Raquel Dexter (1932), showed that no factor had contributed more than the toad to the rescue of the main agricultural crop from destruction.

However, the hero of such a wonderful performance was readily forgotten by many a farmer, as well as by the large sugar-cane corporations, until recently, when the toad population began to decrease. Among the factors responsible for this decrease are: (1) the prolonged periods of drought that dried up the most important breeding areas, especially the Cartagena and Guanica lagoons in southwestern Puerto Rico, (2) the abundance of the aquatic larvae of the Dytiscid beetle, *Megadytes giganteus* Castelnau, predaceous on the immature stages of the toad, (3) lack of food after most of the Maybeetle adults of the

white grubs had been devoured by the toads and (4) ignorance of farmers who destroyed the toads because they thought they ate chicks.

It was believed that one of the additional factors possibly affecting the reduction of the toad in Puerto Rico might be competition with the increasingly abundant bullfrog. The adult frog, living in the same environment as the toad's pollywogs, was suspected of eating them, for there is evidence that the frog in the States eats frog pollywogs (Frost, 1932). With the help of Dr. George N. Wolcott, and at his suggestion, the author studied the stomach contents of the bullfrog in Puerto Rico with the objective of determining the frog's influence, if any, upon abundance of the marine toad.

With the aid of a long-handle net, frogs were caught as early in the morning as possible in a brook in which the pools contained large numbers of the immature stages of both frog and toad. In addition, 12 alcoholic preserved alimentary tracts from the Mavaguez area were very kindly sent by Mr. Harold C. Plank, Entomogist for the Federal Experiment Station in Puerto Rico.

A total of fifty frogs were examined during the year 1948-1949, starting with the month of August.

Immediately after killing, the animal was dissected, the stomach contents placed in a petri-dish and examined with the aid of a binocular. The insects that were found were checked with the Station collection and the snails and undetermined insects were sent to the U. S. National Museum for determination. We are greatly indebted to Mr. C. F. W. Muesebeck for insect and snail identifications and to Miss Doris M. Cochran for confirming identification of the frogs.

Discussion

In none of the fifty frogs dissected during all seasons of the year in Puerto Rico was there any evidence that this amphibian feeds on the toad's pollywogs. However, it does eat pollywogs and small adults of its own species in Puerto Rico, as has previously been reported in the States (Frost 1932).

Although the bullfrog is not as highly effective as the toad in control of the most important economic pests of the island, it does aid to a certain extent. Among the insects of economic importance found in the frog's stomach-contents are the following: *Periplaneta australasiae*—the Australian roach; *Gryllus assimilis*—the common cricket, very destructive to foodstuffs, plants and to clothing; *Nasusitermes costalis*—the "comejen" termite; *Metamasius hemipterus*—the rotten cane stalk borer; *Cosmopolites sordidus*—the banana corm borer, very injurious to bananas; *Diaprepes abbreviatus*—a common injurious leaf weevil which attacks almost every crop both as larva and adult; *Megadytes giganteus*—ferocious enemy of pollywogs of all species; *Belostoma boscii*—enemy of pollywogs, fish, other aquatic insects; *Prodenia*—cutworms; Pyralids (caterpillars); *Musca domestica*—the common housefly; *Solenopsis geminata*—the fire ant, very injurious to many crops.

It is rather interesting to note that the food habits of the bullfrog are considerably more diversified than those of the giant marine toad, *Bufo marinus*. According to Mrs. Raquel Dexter (1932) the highest total (43.3%) of the stomach contents of the toad was of Scarabaeid beetles, with very small percentages of other insects found. The bullfrog, on the other hand, shows more nearly equal percentages of the most important groups of insects and other small animals. This difference in food eaten is most probably due to the fact that

the bullfrog gets its food both from the water and from the ground, whereas the toad catches its food on the ground only.

The mollusk *Australorbis glabratus* (Say), the intermediate host of the common tropical trematode parasite known as Bilarhzia, has been found in a tenth of the frogs' stomachs. Hoffman and Janer (1941) found live ova of the parasite in feces of 26 *Bufo marinus*. Dr. Hoffman considered the toad as a potential menace acting as a mechanical vector of the trematode. Having in mind that the frog's habits are more restricted to water, we might expect the frog to be an even greater menace in this role than the toad.

In general the bullfrog eats the same kind of food in Puerto Rico as has been reported in continental United States (Frost 1924). Practically no items are beneficial to man and although the majority are neutral, some are injurious species. The introduced bullfrog by no means eats as many injurious insects as does the introduced toad, and indeed eats so few of them that it can hardly be considered a serious competitor with *Bufo marinus* for that food-supply.

The adult of each species inhabits its own niche, and if the pollywogs of both live in the same pool, there is usually if not always an ample supply of ever-renewed algae to feed them. So far as our data indicate, the bullfrog is not predaceous on either the pollywogs of the toad, or on the very small adults. Any decrease in the abundance of the toad in Puerto Rico must be ascribed to factors other than the introduction of the bullfrog.

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American Caudata. VII. Two New Salamanders of the Genus Plethodon

By M. B. Mittleman

Recent investigations have brought to light two new salamanders of the genus *Plethodon,* both of which have been heretofore confused with *P. g. glutinosus.* One of the new forms, which occurs in southeastern Kentucky, belongs to the *jordani* group, while the other occurring along the Atlantic coastal plain is a subspecies of *glutinosus* and has probably escaped an earlier description largely because of the evanescent nature of certain details of color and pattern in preserved specimens of *Plethodon.*

I am indebted to Ralph Dury, director of the Cincinnati Natural History Museum, for the loan of specimens and for the opportunity to descirbe the new salamander from Kentucky, which may be known as

Plethodon kentucki, n. sp.

HOLOTYPE.—Cincinnati Natural History Society No. 1521-A; an adult male collected at Pine Mountain, Harlan County, Kentucky, *ca.* 2,000 feet; August, 1933, by W. Cornett.

ALLOTYPE.—Cincinnati Natural History Society No. 1521-B; an adult female, same date as holotype.

PARATYPES.—Twenty-three, as follows: CNHS 1521 C-J, same data as holotype; CNHS 1675 A-B, near Virgie, Pike County, Kentucky; CNHS 2513 A-B, Big Black Mountain, Harlan County, Kentucky; CNHS 1710 A-K, near Cumberland, Harlan County, Kentucky.

DIAGNOSIS.—A moderately small member of the *jordani* group lacking red markings; with reduced pigmentation of the throat, breast, and sometimes the anterior third of the belly, the belly black or slatey; limbs long, appressed toes usually overlapping by 0.5 to 2 costal spaces; vomerine series fairly short, ending at outer border of nares or but slightly beyond.

DISCUSSION.—The combined vomerine count in 14 male *P. kentucki* of 34 to 60 mm. snout-vent length varies from 16 to 24, and averages 19.3 + - 2.27 (standard deviation), while in 9 females with a snout-vent range of 36. - 52.0 mm. the count varies from 15 to 23 and averages 19.5 + - 2.33; the observed sexual difference in vomerine counts is statistically insignificant. The length of the individual vomerine series is apparently sexually dimorphic, insofar as male specimens usually have 1 or 2 vomerine teeth in the series extending laterally beyond the outer edge of the nares, while in females almost invariably the vomerine teeth in a series end at a point exactly opposite the outer edges of the nares or even within the opening of the nares itself. Sexually immature males are similar to females in the extent of the vomerine series. No correlation between age (size) and vomerine count is discernible in *kentucki*; for example a 48 mm. (snout-vent length) female has a combined vomerine count of 23, while another female of 46 mm. has a count of 15, and a third female specimen of 51.5 mm. has a count of 19. Two sexually immature males of 34 and 31 mm. respectively have counts of 18 and 14, while another immature male has a count of 16, and two mature males of 49.5 mm. and 50 mm. likewise have counts of 16.

The appressed toes just meet in a single specimen out of a total of 25. In the remaining 24 individuals the toes overlap by half a costal space in 10 specimens, by a full costal space in 6 specimens, by one and a half costal spaces in 4 specimens, and by two costal spaces in 4 specimens. Without exception the costal groove count is 15, counting an inguinal branch of the fourteenth groove

which invariably appears in every specimen observed.

Oviposition in *kentucki* apparently occurs in early September, for specimens taken in August have ova about one millimeter in diameter, or slightly larger. Breeding females may be as small as 36.5 mm. in snout-vent length; a specimen of this size (CNHS 1710-J) collected on June 12th has small ova varying from about 0.25 to 0.5 mm. in diameter, while larger females taken at the same locality and on the same day have ova approximating only 0.5 mm. or but slightly larger. In a series of eight sexually mature females (omitting the 36.5 mm. individual) the average snout-vent length is 49.8 mm., the range being 46 - 52 mm. Male specimens appear to average slightly larger in size, for 13 specimens that are sexually mature (tumescent testes, mental glands, cloacal papillae) average 52.8 mm., ranging from 45 to 60 mm. Male specimens of 34 and 35 mm. snout-vent length are definitely immature sexually; the next specimen in a size-ranking is 45 mm. long and is sexually mature. Sexual maturity in males may occur at about 40 mm. snout-vent length.

Sexual dimorphism in *P. kentucki* is to be observed also in the shape of the head, which in mature males is evidenced by a sharply truncated snout, while in females the snout is somewhat more rounded and spatulate. In mature specimens of both sexes there is a tendency to develop bulbous swellings on the upper lip at the base of the naso-labial groove; this is particularly perceptible in males, for the naso-labial swellings are sufficiently large to cause the snout to have its characteristic square-cut or truncated appearance, and to impart a pronouncedly sinuous aspect to the lateral profile of the upper lip.

Measurements of the holotype and allotype are as follows (allotype in parentheses): snout-vent length 49 mm. (51.5 mm.); tail length 59 mm. (49 mm. - regenerated); snout to midpoint of gular fold 12.6 mm. (13.7 mm.); head width 8.1 mm. (8.4 mm.); width of trunk at midbody 6.6 mm. (6.5 mm.).

It is regrettable that no notes are available on the colors and pattern of *P. kentucki* in life. It seems likely that *kentucki* differs even more strikingly in life from other members of the *jordani* group than the present notes would indicate. No red appears in preserved specimens of *kentucki*, although the cheeks below the postorbital groove are conspicuously lighter in most specimens than is the rest of the head. However, as nearly as can be determined, the light cheeks result from a dorsolateral extension of the characteristically open rete (reduced melanophores) of the throat and breast regions. The throat and breast in *kentucki* vary from almost white to a pale gray with an overlay of slightly darker stippling. The whitish effect arises from the reduced melanophores rather than from the presence of guanophores. In addition, in some specimens a few clusters of guanophores are present on the throat and breast. The dorsum is blue-black, similar to preserved *jordani*, either unicolor or with a very sparse flecking of white. In a few individuals small open clusters of guanophores are present on the dorsal and lateral surfaces of the tail and suggest a faint frosted pattern. The sides of the body are virtually immaculate; some specimens have a few flecks of white. Generally, if any white is visible at all it is present on the posterior portions of the sides of the head, and just anterior to the insertions of the fore limbs. The light color of the breast and throat does not usually extend to the belly, which varies from a slatey color to almost black, although in some specimens the melanophores are much reduced for a third of the belly posterior to the fore limbs, so that this portion of the belly is nearly as light as the breast. The soles and palms are very light colored, approximating the throat; the light color of the palms and soles extends in many specimens to the knee and elbow joints respectively, and in some individuals extends almost to the point of insertion of the limb but in a mottled effect against the darker background color.

The relationships of *kentucki* are not at all clear. In structure and color it is apparently a member of the *jordani* group, but its affinities are not obvious. The seeming absence of red pigment suggests a relationship to *metcalfi*, which is also the nearest form geographically having been collected at various stations in western Virginia (Tazewell and Grayson counties). However *kentucki* differs notably from *metcalfi* in lacking a brownish or fawn tint to the belly pigment, in its higher vomerine count, in its slightly larger average size, and its much longer limbs. The long vomerine series and lack of red pigment in *P. kentucki* are reminiscent of *P. yonahlossee*, but it differs from the latter species in many respects, such as smaller size, fewer vomerine teeth, longer limbs and lack of a brownish or chestnut dorsal stripe. If Hairston and Pope (1948 Evolution, 3: 276-277) are correct in suggesting that *yonahlossee* or a primitive *yonahlossee*-like form is the ancestor of the *jordani* group, and thereby of *kentucki* too, then perhaps the best disposition of the relationships of *kentucki* to other members of its group is simply to postulate that *kentucki* developed *in situ* from an early *yonahlossee*-progenitive stock and is closer to neither one form nor another of the *jordani* group.

Since *kentucki* has been confused heretofore with *P. g. glutinosus*, and shares its habitat with the latter form, a comparison of these two salamanders may not be amiss. The two are separable in preserved material by a number of criteria that are probably augmented by additional color differences in life. Of the two, *kentucki* is much the smaller animal, averaging 52.8 mm. snout-vent length in sexually mature males, and 49.8 in sexually mature females. By contrast, Pope and Pope (1949, Fieldiana, 31, 29:255) report that sexually mature *glutinosus* from various upland stations in extreme western Virginia and adjacent West Virginia average 61 mm. in males and 66 mm. in females. The limbs are

proportionately longer in *kentucki* than they are in *glutinosus,* the toes of the appressed limbs in the former almost invariably overlapping, while in the latter they are usually separated by one and a half or more costal spaces. Further, when the forelimb is applied forward in *kentucki* it reaches at least midway between the angle of the eye and the nostril, and often touches the nostril; in *glutinosus* the forelimb applied forward reaches to the center of the eye, or at most just barely ahead of the anterior angle of the eye. Pattern differences between the two forms are most obvious in the light throat, breast, and cheeks of *kentucki* (aside from any white flecks, dots, or spots that may be present), whereas in *glutinosus* the throat, breast, and cheeks (as well as the remainder of the dorsum and venter) are dark-colored except for such white spots or patches as may occur.

* * * * * *

While driving north along U. S. Highway 17 in the coastal plain of North Carolina on November 10, 1950, a few attempts were made to collect amphibians and reptiles. At one point, in rather dry bottomlands bordering a small creek about 13 miles north of New Bern, in Craven County, four salamanders were found under and in a large rotten pine log; associated with the salamanders was a half grown *Microhyla c. carolinensis*. About 60 airline miles farther north on the highway, in a sawdust pile covered with yellow pine slabs, another salamander was taken, this time in association with a lizard, *Sceloporus u. hyacinthinus*. Despite several more stops and additional investigation of likely looking spots, only two more salamanders were seen, both of whch eluded capture; these specimens were found together in a huge rotten pine log, in recently-flooded bottomlands which had largely dried out, in company with a newly transformed *Hyla femoralis*.

The five salamanders were brought alive to New York and kept for two months. One female is still alive, the remaining specimens were killed and preserved. Examination and comparison with other populations of *P. g. glutinosus* shows that these North Carolina individuals display constant differences which set them apart from *glutinosus*; hence they should be recognized as a distinct race which may be known as

*Plethodon glutinosus chlorobryonis**, n. ssp.

HOLOTYPE.—An adult male in my personal collection, to be deposited in the United States National Museum; collected by C. B. Goodstein and myself in dry bottomlands along a small creek 13 miles north of New Bern, Craven County, North Carolina, along U. S. Highway 17, on November 10, 1950.

ALLOTYPE.—An adult female in my personal collection to be deposited in the United States National Museum; same data as holotype.

PARATYPES.—Nine, as follows: a preserved specimen, and a living individual, both in my possession, to be deposited in the United States National Museum, same data as holotype; a preserved specimen in my collection, also to be deposited in the United States National Museum, taken in a sawdust pile 4 miles north of Windsor, Bertie County, North Carolina, along U. S. Highway 17; USNM 83469, 91725-6, Lake Waccamaw, Columbus County, North Carolina; USNM 84206-7, Williams Mill Pond, Gates County, North Carolina; USNM 124354, 8 mi. E. of Winfall, Perquimans County North Carolina.

DIAGNOSIS.—A race of *Plethodon glutinosus* characterized in life by reduction of the dorsal white spots, by a lateral pattern of greenish-white or

**chlorobryonis*, from the Greek *chloro* (green) + *bryon* (lichen), in allusion to the greenish lichenoid patches on the sides of this salamander in life.

yellow-green lichenoid patches, by small orange-gold dots on the breast and venter, and by reduced vomerine counts and a smaller average adult size than exists in the nominate race.

DISCUSSION.—Of the ten specimens of *chlorobryonis* available to me at this writing for internal examination, seven are gravid or post-partum females, while three male specimens are all sexually mature and were evidently taken during the breeding season since they have enlarged testes, cloacal papillae, and prominent mental glands. The eleventh specimen at hand is still living, and appears to be a mature female. The snout-vent lengths of the seven preserved females vary from 47.5 to 61 mm., and average 58.7 mm. The three male specimens have snout-vent lengths of 52, 57, and 69 mm., averaging 59.3 mm. The female specimens all contain ova which vary in size from about 0.25 mm. to 3 mm. Dimensions of the holotype and allotype (in parentheses) are as follows: snout-vent length 57 mm. (60 mm.); tail length 64 mm. (61 mm.); snout to midpoint of gular fold 13.5 mm. (13.4 mm.); head width 8.9 mm. (8.7 mm.); width of trunk at midbody 7.7 mm. (7.6 mm.). So far as the three males may be compared with the seven females, the males have proportionately longer heads and tails, wider heads, and attain a greater snout-vent length. In addition, the males have prominently truncate snouts (due to the nasolabial swellings), while the females have trunco-spatulate snouts due to the much smaller nasolabial swellings, or even the absence of these hedonic appurtenances.

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The vomerine counts in *chlorobryonis* average less than they do in *glutinosus*. The combined vomerine counts and snout-vent lengths of the three males are as follows: 15 (52), 15 (57), 14 (69); comparable data for the seven females are: 15 (47.5), 17 (56), 14 (56.5), 15 (58), 15 (60), 16 (60), 15 (61). There is no valid difference between the vomerine counts of males and females, and the average for all ten specimens is 15.1 teeth. By contrast, Pope and Pope (1949: 253, fig. 60) show that in 14 comparable specimens of *P. g. glutinosus* of both sexes in the 55-60 mm. snout-vent length class, from western Virginia and adjacent West Virginia, the range is from 17 to 26 vomerine teeth per specimen, and the average is 21. Bishop (1941: 220), in speaking of *glutinosus* in New York says that there are 12 or 13 teeth per series, which would result in a combined count of 24 to 26. Grobman (1944: 284) reports a combined vomerine count of 19.2 in a mixed lot of *glutinosus* from various localities. In addition to a lower average vomerine count, the physical dimensions of the individual vomerine series are smaller in *chlorobryonis* than they are in *glutinosus*, for almost every writer having to deal with the latter salamander has described the vomerine series as extending well beyond the outer border of the internal nares, whereas in the new race the vomerine series terminate well within the nares, or just about at the outer border of the nares.

In general proportions *chlorobryonis* appears to be a more slender and graceful animal than *glutinosus*. The limbs are longer in *chlorobryonis* than they are in *glutinosus*, for in the new race the limbs are separated by half a costal space or one costal space in 9 specimens, and by a space and a half in one specimen, while in *glutinosus* of comparable size the appressed limbs are separated by at least one and a half spaces and as many as two and a half spaces. The more slender body of *chlorobryonis* is indicated by the body width entering the snout-vent length from about 7.5 to about 8.5 times, while in the nominate race the greater body width enters the snout-vent length about 6 to 7 times. Proportionate tail length is the same in both *chlorobryonis* and *glutinosus*, but in the former the tail somehow gives the impression of being slenderer and also more compressed than

in *glutinosus*.

The tail of *chlorobryonis* is surprisingly prehensile, and the animal itself shows a marked predilection for climbing. When held in the hand, or on a twig, the tail is invariably wrapped around the perch as though to obtain a better purchase, and if the animal should be suddenly tilted the caudal grasp is immediately and perceptibly tightened, so that if the angle of tilt is finally extended to the point where the perch is vertical or upside down, the animal dangles by its tail with a perfectly firm grip and seemingly not particularly disturbed. When climbing a relatively slender branch, the tail is partially wrapped around the branch, and appears to lend the salamander definite purchase and support while climbing; if the climbing is done over a rock or bark, the tail is used to push with, thus providing the animal with traction. Further, it has been noted on several occasions that the tail is used for locomotive purposes, or saltation, for if the animal is suddenly disturbed it will literally leap forward for as much as three inches and upwards at least an inch, apparently accomplishing this remarkable feat by using its tail as a sort of spring mechanism. A similar characteristic has been noted in the tree-climbing *Aneides flavipunctatus* by Storer (1925: 123), who reports also that this West Coast salamander has a prehensile tail. The saltative use of the tail in forms like *chlorobryonis* and *A. flavipunctatus* is probably related to the caudivagant tail function in salamanders such as *Pseudoeurycea c. rubrimembris, P. galeanae* (Taylor and Smith, 1945: 540-1), and *Hydromantes platycephalus* (Stebbins, 1947: 1-5). Smith (1947: 1-2) and Stebbens (*loc. cit.*) have suggested that the caudivagant mechanism in salamanders is somehow an adaptation to a rocky and barren habitat, and while useful for a rupicolous species is probably unnecessary for humus-dwelling forest forms. I suspect that the combination of a prehensile tail and climbing ability (and predilection) in *chlorobryonis* are indicative of certain regular activities which place a premium on these attributes. The low coastal plain habitat of *chlorobryonis* is regularly inundated, and with little topographic relief to provide a refuge in flood times the ability to resort to the safer and drier haven afforded by a tree might well have positive survival value.

The colors and patterns displayed by *chlorobryonis* immediately set it apart from *glutinosus* at least in life. Dorsally the head, body, and tail are blue-black, as in *glutinosus,* but the prominent white spots and patches so characteristic of this latter form are in *chlorobryonis* reduced to a scant flecking of tiny blue-white dots averaging about 0.2 mm. in diameter. The sides of the head, neck, body, and tail, as well as the ventrolateral portions of the body are prominently marked with heavy lichenoid patches of a greenish tint approximating Oyster Gray to Mineral Gray or Artichoke Green (Pl. 19 A2, P1. 20, A2 and B2. Maerz and Paul, 1950). But by far the most distinctive color feature in life of *chlorobryonis* is the orange or golden dots (Cadmium Orange L10, Princeton Orange Kll, or Golden Poppy L12, Pl. 9, Maerz and Paul, 1950) superimposed all over the blue-gray ventral surfaces from the gular fold to a point just anterior to the vent; these dots vary from about 0.2 to 0.5 mm. in diameter. Whatever genetic mechanism causes the golden ventral punctations in *chlorobryonis,* the analogue of it appears in the recently-described *P. g. grobmani* which has the dorsal surfaces of the head and body sprinkled with golden dots (Allen and Neill, 1949: 112). The dots in *grobmani* are described as having a metallic lustre, but this quality is lacking in *chlorobryonis.* The pigments producing the golden dots in the new race are highly soluble, for within 48 hours after preservation in formaldehyde the dots are a lemon-yellow shade, and within a few days thereafter they are merely a grayish

white. The greenish or yellow-green pigments of the lichenoid patches are somewhat more stable, since they retain at least half of their original intensity for at least a month after preservation in formaldehyde.

Specimens presently available indicate that the range of *chlorobryonis* extends in the North Carolina coastal plain from Gates, Bertie, and Perquimans counties in the north to Columbus County in the south. Specimens considered as intermediate between *chlorobryonis* and *glutinosus* or else possibly intergrade between the two races, have been seen from Cypress Chapel, Nansemond County, Virginia (USNM 127709-12); Creedmoor, Granville County, North Carolina (USNM 91335-8); Raleigh, Wake County, North Carolina (USNM 16636, 22176, 49684, 91580-4); Goose Creek, Berkeley County, South Carolina (USNM 14453); and Charleston, South Carolina (USNM 3784). These intermediates or intergrades share various traits in that they tend to have fewer teeth than do typical *glutinosus,* or else reduced dorsal spotting and a concomitantly heavier lateral spotting occasionally with a slightly greenish tinge, or somewhat longer limbs than is usual in the nominate form. But none of these specimens shows the combination of characters which collectively set *chlorobryonis* apart from *glutinosus*. The limiting factors in the distribution of *chlorobryonis* are not known, since there is no apparent barrier to maintain racial differentiation between the populations of salamanders occurring in extreme northeastern North Carolina and those of the Dismal Swamp in nearly adjacent Virginia; yet the Dismal Swamp population shows only a moderate trend towards *chlorobryonis,* chiefly in the reduced dorsal spotting and relatively heavier lateral spotting, while salamanders collected 20 to 30 miles further south in Gates and Perquimans counties, North Carolina are quite typical *chlorobryonis*. Altitudinally, the new form apparently does not range beyond the 100-foot contour in the coastal plain. In a southerly direction, the extreme limit is now represented by specimens from Lake Waccamaw, Columbus County, North Carolina, although almost certainly *chlorobryonis* extends into northeastern South Carolina. Neill (1948) has described a peculiar variant of *glutinosus* which lacks any white pigment, from Jasper County, South Carolina, and other specimens with reduced white pigment from northern Jasper County up to about Berkeley and Charleston Counties, South Carolina. The few specimens I have seen from the latter two counties I would consider intermediates or intergrades between *chlorobryonis* and another population of *glutinosus* (*sensu lato*), perhaps *grobmani* or a population annectant of *grobmani* and *chlorobryonis*.

Several characters in the species *glutinosus* evidence a north-south gradient. Thus, costal grooves are usually 16 in northern coastal plain specimens, with about two costal spaces between the appressed toes; in *chlorobryonis* there are 15 grooves and usually one space between the appressed toes, while in *grobmani* the costal groove count is 14 or 15, with one or a fraction of one space between the appressed toes. Vomerine counts have not been reported for *grobmani,* but if the north-south gradient of *glutinosus* and *chlorobryonis* extends to this southernmost race it will probably be found to have a count averaging about 14, or perhaps less. The north-south cline is evident also in color, for there is a gradual diminution in intensity of the belly pigment from deep black in the north to slate in the south, with a corresponding increase in the extent and intensity of light lateral pigmentation. Finally, from north to south there is a clear trend of reduction in snout-vent length: northern *glutinosus* average about 68 mm. in snout-vent length, while 10 adult *chlorobryonis* of both sexes average 57.7 mm. and *grobmani* is reported to average 53.7 mm.

The differentiation of three races of *glutinosus* along the Atlantic Coastal Plain suggests the desirability of investigating the geographically correlatable variations in other populations of this species. Grobman (1944: 281) has already pointed out the existence of a large unicolor form of *glutinosus* which occurs southward from the Cumberland Plateau. This population may well be found to possess characters which consistently set it apart from other populations of the slimy salamander. Similarly, casual examination of some 50-odd specimens of *glutinosus* from the unglaciated plateau of Ohio, Indiana, and Illinois indicates that the vomerine counts of these specimens are apparently consistently lower than are those of other upland populations of *glutinosus*; it is quite possible that a recognizable race occurs in the southern Ohio River drainage system. Similarly, the slimy salamanders of the Ozark and Ouachita Plateaus may be demonstrably different from other populations of *glutinosus*. The only certainty is that *glutinosus* as now defined and recognized is a polytypic form composed of vicarious races, several of them undefined and unnamed.

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A Systematic Arrangement of the Family Amphisbaenidae (Sauria).

By P. E. Vanzolini

The following generic catalog and keys are a result of revision of the Recent and fossil genera of Amphisbaenidae, based chiefly on the characters of the skull and scutellation. The anatomical, zoogeographical and evolutionary parts of the revision are rather bulky, and I do not expect to see the complete paper in print before the middle of 1952. In order to make my conclusions available and to clear the way for some generic revisions in process, I deemed it useful to publish separately the systematic arrangement to which the morphological research led, as well as keys for the identification of the Recent genera.

The definitions are concise and do not include characters which are common to the group or not especially diagnostic. When no mention is made of skull characters, it is because no such information is available. The dental formula is summarized by citing the premaxillary, maxillary and mandibular number of teeth in the order named, separated by semicolons. Variation of these numbers is indicated by citation of the extreme values, separated by a dash.

For the sake of brevity no bibliographical citations are given in the text, inasmuch as all the genera are redefined. The pertinent information will be found in the papers listed in the Bibliography.

Family Amphisbaenidae Gray, 1825

Subfamily Amphisbaeninae, subfam. nov.

Cranium in frontal plane of body. Snout rounded or laterally compressed. Nostrils lateral. Vertical process of the premaxilla narrow. Basipterygoid processes present or absent. Partes posteriores choanarum present or absent. Supratemporal bones present or absent. No postarticular process of the lower jaw. Dentition pleurodont. Preanal pores present, except in the females of some forms.

Bipes Latreille, 1802

Synonyms: *Chirotes* Cuvier, 1817 (type, *canaliculatus*)
Bimanus Oppel, 1811 (type, *propus*)
Euchirotes Cope, 1894 (type, *biporus*)
Hemichirotes Duges, 1894 (type, *tridactylus*)

Genotype. B(ipes) canaliculatus Bonnaterre, 1789.

Definition. Snout rounded. Basipterygoid processes, partes posteriores choaninasmuch as all the genera are redefined. The pertinent information will be plate. Quadrate expanded proximally. Meckel's groove open. Dentition 7; 3; 6. Anterior limbs present. One unpaired shield on top of the head, adjacent to the rostral. Nasal shields not fused to the first labials.

Distribution. Mexico (Guerrero, Baja California); .U. S. (southeastern Arizona).

Blanus Wagler, 1830

Genotype. Amphisbaena cinerea Vandelli, 1797.

Definition. Snout rounded. Basipterygoid processes, partes posteriores choanarum and supratemporals present. Quadrate expanded proximally. Meckel's groove open. Dentition 7; 3-4; 7-8. One unpaired shield adjacent to the rostral. Nasal shields fused to the first labials.

Distribution. Northwest Africa; Iberian Peninsula; Island of Rhodes; Asia Minor.

Cadea Gray, 1844

Genotype. Cadea blanoides Stejneger, 1916 (=*Amphisbaena punctata* Bell, 1828, preoc.).

Definition. Snout compressed, pointed, or raised in a small keel. Basipterygoid processes, partes posteriores choanarum and supratemporals present. Quadrate proximally dilated. Meckel's groove open. Dentition 7; 5; 7. One unpaired median shield adjacent to the rostral. Nasal shields separated from first labials.

Distribution. Cuba; Isle of Pines.

Amphisbaena Linne, 1758

Synonyms: *Sarea* Gray, 1844 (type, *caeca*)
Aporarchus Cope, 1885 (type, *prunicolor*)

Genotype. Amphisbaena fuliginosa Linne, 1758.

Definition. Snout rounded, flattened or little convex above, sometimes slightly compressed and bent. Basipterygoid processes, partes posteriores choanarum and supratemporals absent. Quadrate rod-like. Dentition 7; 4-5; 7-9. Upper head shields paired. Nasal shields meeting on the mid-line.

Distribution. South America, except Patagonia and the Andes south of Peru; Panama; Greater Antilles except Jamaica; Mozambique (*A. violacea,* only non-neotropical species of the group.).

Diphalus Cope, 1861

Genotype. Diphalus fenestratus Cope, 1861.

Definition. Snout pointed. Nasal shields separated by rostral, which is narrow above. Dentition 5; 4; 7. (Not seen).

Distribution. Virgin Islands.

Bronia Gray, 1865

Genotype. Bronia brasiliana Gray, 1865.

Definition. Snout pointed, convex, strongly bent. Skull similar to that of *Amphisbaena* in other respects. Dentition 7; 5; 8. Nasal shields separated by and often fused to the rostral, which is broad above.

Distribution. Lower Amazon.

Loveridgea, gen. nov.

Genotype. Amphisbaena phylofiniens Tornier, 1899.

Definition. Snout compressed, strongly bent. The premaxilla forms an anterior vertical keel. Basipterygoid processes and supratemporal absent. Partes posteriores choanarum present, sometimes reduced. Quadrate rod-like. Dentition 7; 4; 6. Four pairs of large shields behind the rostral (one more than in *Amphisbaena*).

Distribution. Tanganyika Territory.

Referred Species. Amphisbaena ionidesi Battersby, 1950.

Genus named after Mr. A. Loveridge, of the Museum of Comparative Zoology, Harvard University, in acknowledgment of his valuable work on African amphisbaenids and of the many kindnesses for which I am in his debt.

Geocalamus Guenther, 1880

Genotype. Geocalamus modestus Guenther, 1880.

Definition. Snout compressed, bent. Basipterygoid processes, partes posteriores choanarum and supratemporals absent. Nasal bones very small. Dentition 3; 3; 6. Rostral shield very large, not fused to nasals. One unpaired median shield on top of the head, not in contact with the rostral. Pectoral segments slightly modified.

Distribution. Tanganyika Territory. Kenya Colony.

Mesobaena Mertens, 1925

Genotype. Mesobaena huebneri Mertens, 1925.

Definition. Snout strongly compressed but not raised in a keel. Nasal shields not fused to rostral. A pair of elongate prefrontal shields, lying alongside the rostral and barely meeting behind it. (Not seen.)

Distribution. Rio Inirida, Venezuela.

Anopsibaena Stejneger, 1916

Synonym: *Anops* Bell, 1833 (*type, kingii*) preoc.

Genotype. Anops kingii Bell, 1833.

Definition. Snout strongly compressed, raised into a keel, which is formed by the premaxilla, which separates the nasals. Basipterygoid processes, partes posteriores choanarum and supratemporals absent. Quadrate rod-like. Dentition 7; 3; 7. Rostral shield enormous. Nasal shields not fused to rostral.

Distribution. Southernmost Brasil, Uruguay and adjacent parts of Argentina.

Baikia Gray, 1865

Genotype. Baikia africana Gray, 1865.

Definition. Snout compressed, raised into a keel which is formed by the premaxilla, nasals and frontals. Nasals meeting on the midline. Basipterygoid processes, partes posteriores choanarum and supratemporals absent. Dentition 7; 4; 6. Rostral shield enormous, nasals partly fused to it. A fold between head and body. (Not seen.)

Distribution. West Africa (only the type known, without exact locality data.)

Ancylocranium Parker, 1942

Genotype. Anops somalicus Scortecci, 1930.

Definition. Snout compressed, raised into a keel, formed by the premaxilla, nasals, frontals and part of the parietal plate. Anterior part of the parietal plate (the part which forms the keel) turned backward horn-like. Basipterygoid processes, partes posteriores choanarum and supratemporals absent. Quadrate proximally dilated. Rostral shield enormous, with straight posterior margin; nasals fused to it.

Distribution. Italian Somaliland. Tanganyika Territory.

Cynisca Gray, 1844

Synonym: *Ophioproctes* Boulenger, 1878 (type, *liberiensis*)

Genotype. Amphisbaena leucura Dumeril & Bibron, 1839.

Definition. Snout rounded. Fronto-parietal suture dentate. Basipterygoid processes present or absent. Partes posteriores choanarum and supratemporals absent. Quadrate dilated proximally, with an extracodumeller groove and no postpterygoid process. Dentition 7; 4; 7. An azygos frontal shield present or not. Frequent fusions of shields (especially the anterior ones) of each side of the head.

Distribution. West Africa, from the Portuguese Guinea to the French Congo.

Shrevea, gen. nov.

Genotype. Amphisbaena quadrifrons Peters, 1862.

Definition. Snout rounded. Basipterygoid processes, partes posteriores choanarum and supratemporals absent. Quadrate dilated proximally. A peculiar postorbital arch formed by the parietal and the pterygoid. Dentition 7; 4; 7. Prefrontal shields longitudinally divided, four in all. No fusion of head shields.

Distribution. Africa, from the Belgian Congo to the Cape Colony.

Referred Species. Tentatively (not seen), *Amphisbaena dolichomenta* ssp. Witte & Laurent.

Genus named after Mr. Benjamin Shreve, of the Museum of Comparative Zoology, Harvard University.

Placogaster Boulenger, 1906

Genotype. Placogaster feae Boulenger, 1906.

Definition. Similar to *Cynisca,* but having the ventral segments of both sides fused.

Distribution. Sierra Leone; Portuguese Guinea.

Chirindia Boulenger, 1907

Synonym: *Amphisbaenula* Sternfeld, 1911 (type, *orientalis*)

Genotype. Chirindia swynnertoni Boulenger, 1907.

Definition. Snout swollen. Fronto-parietal suture not dentate. Basipterygoid processes, partes posteriores choanarum and supratemporals absent. Quadrate dilated proximally, with an extracolumellar groove and a postpterygoid process. No azygos frontal shield. Extensive fusions of anterior head shields of each side.

Distribution. Tanganyika Territory; Southern Rhodesia; Transvaal; Mozambique.

Subfamily Rhineurinae, subfam. nov.

Cranium tilted in relation to frontal plane of body. A strong craniofacial angle. Face flattened, snout shovel-like, with a sharp horizontal edge. Nostrils inferior (except in †*Jepsibaena*). Vertical processes of premaxilla broad, triangular (except in †*Jepsibaena*). Lower jaw with a long postarticular process. Basipterygoid processes present. Partes posteriores choanarum present (except in *Leposternon*). Supratemporal present. Dentition pleurodont. A number of large unpaired median shields on the head. Rostral not forming the edge of the snout (except in *Aulura*). Pectoral shields enlarged. A gular fold. Preanal pores present or absent.

†*Jepsibaena,* gen. nov.

Genotype. †*Ototriton minor* Gilmore & Jepsen, 1945.

Definition. Snout rounded. Nostrils lateral. A long postarticular process of the lower jaw, almost on the continuation of the long axis of the bone.

Distribution. Lower Eocene of the Western United States.

Remarks. The most primitive form of the subfamily, probably transitional between the ancestral amphisbaenine-like stock and the typical rhineurines.

Named after Dr. Glenn L. Jepsen, of Princeton University.

†*Ototriton* Loomis, 1919

Genotype. †*Ototriton solidus* Loomis, 1919.

Definition. Typical rhineurine skull. Nasals meeting on the midline. Three premaxillary teeth.

Distribution. Lower Eocene of the Western United States.

Rhineura Cope, 1861

Genotype. Lepidosternon floridanum Baird, 1858.

Definition. Nasals moderate, meeting behind the premaxilla. Postarticular process of the mandible oblique. Dentition 1; 5; 6. Pectoral shields little enlarged. No preanal pores. Tail with dorsal rows of tubercles.

Distribution. Florida (Recent). Oligocene of the Western United States.

†*Pseudorhineura,* gen. nov.

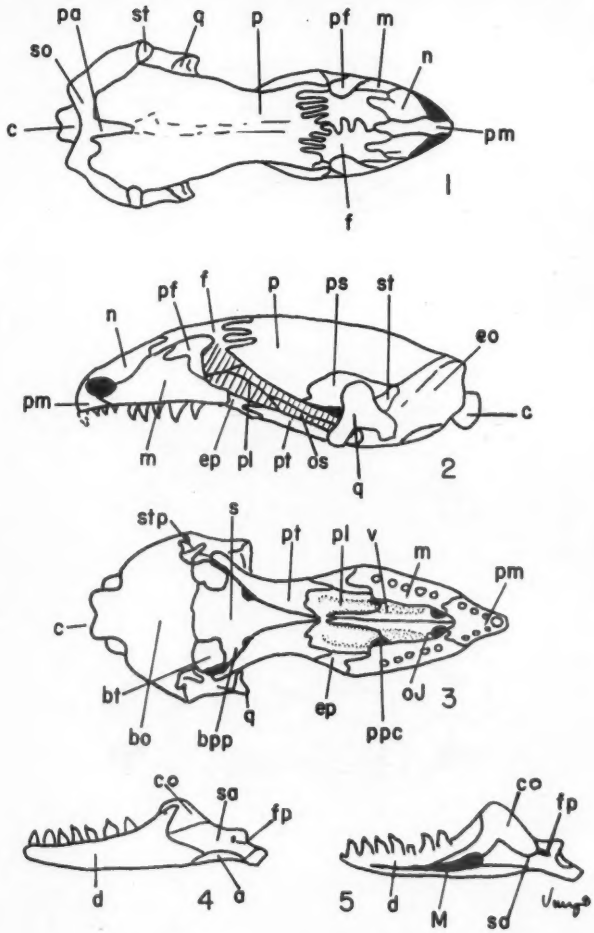
Genotype. †*Rhineura minutus* Gilmore, 1938.

Definition. Similar to the fossil forms of *Rhineura,* but with much more elongate nasals and with the fenestra ovalis displaced far backwards.

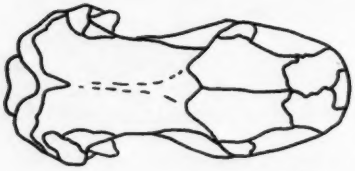
Distribution. Oligocene of western United States.

†*Hyporhina* Baur, 1893

Genotype. †*Hyporhina antiqua* Baur, 1893.



Figures 1 - 5. *Cadea blanoides*. Skull and mandible.
a articular; bo basioccipital; bpp basipterygoid process; bt basitemporal bone; c occipital condyle; co coronoid; d dentary; eo exoccipital; ep ectopterygoid; f frontal; fp posterior foramen; m maxilla; M Meckel's groove; n nasal; oJ foramen Jacobsoni; os orbitosphenoid; p parietal; pa processus ascendens tecti synotici; pf prefrontal; pl palatine; pm premaxilla; ppc pars posterior choanae; ps pleurosphenoid; pt pterygoid; q quadrate; s basisphenoid + parasphenoid; sa surangular; so supraoccipital; st supratemporal; stp stapes; v vomer.



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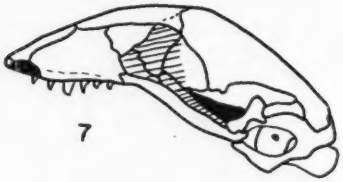

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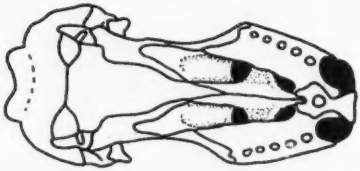

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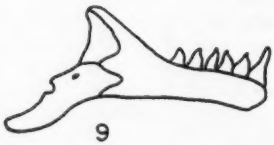

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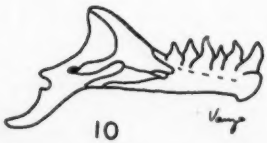

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Figures 6 -10. *Rhincura floridana*. Skull and mandible.

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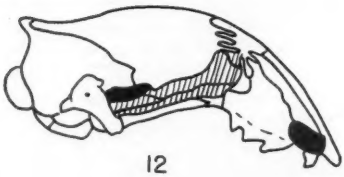

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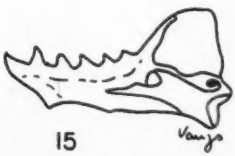

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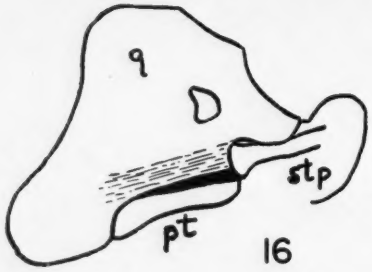
Figures 11 - 15. *Pachycalamus brevis*. Skull and mandible.



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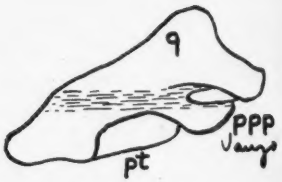

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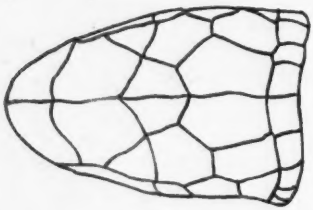
Figures 16 - 17.
16. *Cynisca leucura*. Quadrate.
17. *Chirindia orientalis*. Quadrate.
q quadrate; pt posterior extremity of pterygoid; stp stapes; ppp post-pterygoid process of quadrate.



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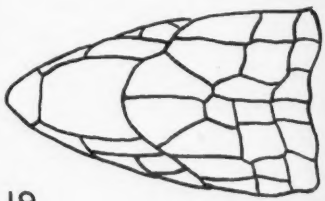

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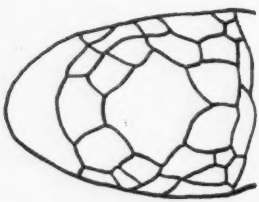

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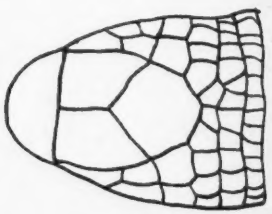

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Figures 18 - 21. Dorsal cephalic scutellation of amphisbaenids.
18. *Amphisbaena slevini*
19. *Cadea blanoides*
20. *Rhineura floridana*
21. *Pachycalamus brevis*

Definition. Postorbital bar present. Nasals barely meeting behind the premaxilla.

Distribution. Oligocene of western United States.

Monopeltis A. Smith, 1848

Synonyms: *Phractogonus* Hallowell, 1852 (type, *galeatus*)
Monotrophis Gray, 1865 (type, *galeatus*)
Dalophia Guenther, 1865 (type, *welwitschii*)

Genotype. Monopeltis capensis A. Smith, 1848.

Definition. Face strongly produced laterally. Nasals separated on the midline. Two postarticular processes of the lower jaw. Prearticular not fused to articular-surangular. Dentition 1; 3-4; 6-7. Head with one or two very large dorsal shields. Nasal shields separated by rostral. Pectorals very much enlarged. Preanal pores present or absent. Tail normal.

Distribution. Tropical and northern South Africa.

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Tomuropeltis Laurent, 1947

Synonym: *Dalophia* Loveridge, 1941 (*nec.* Guenther, 1865)

Genotype. Monopeltis giganteus Peracca, 1903.

Definition. Very similar to *Monopeltis,* but the nasal shields are not separated by the rostral, and the tail has a terminal callous pad.

Distribution. Tropical and northern South Africa.

Leposternon Wagler, 1825

Synonyms: *Lepidosternon* auct.
Cephalopeltis Mueller, 1831 (type, *cuvieri* Mueller, 1831 = *scutigerum* Hemprich, 1829)

Genotype. Leposternon microcephalum Wagler, 1825.

Definition. Snout pointed. Nasals not meeting on the midline and excluded from the rim of the nostrils. Partes posteriores choanarum absent. Dentition 7; 5; 7. Several large shields on top of head. Pectoral shields highly variable. Preanal pores absent.

Distribution. Central Brasil to Paraguay to the coast.

Aulura Barbour, 1914

Genotype. Aulura anomala Barbour, 1914.

Definition. Upper head shields symmetrical. Preanal pores.

Distribution. Lower Amazon.

Subfamily Trogonophinae, subfam. nov.

Snout rounded or shovel-shaped. Partes posteriores choana and basipterygoid processes present. Premaxilla very large. Dentary very large, occupying most of the labial aspect of the mandible. Dentition acrodon. Tail tapering.

Trogonophis Kaup, 1830

Genotype. Trogonophis wiegmanni Kaup, 1830.

Definition. Snout rounded. Anterior process of parietal meeting premaxilla. Nostrils lateral. Upper head shields paired. No preanal pores.

Distribution. Northwest Africa.

Pachycalamus Guenther, 1881

Genotype. Pachycalamus brevis Guenther, 1881.

Definition. Snout shovel-shaped, moderate. Nostrils lateral. Dorsal keel of parietal plate very low and rounded. One pair and several unpaired upper head shields. Rostral forming the edge of the snout. Preanal pores.

Distribution. Socotra Island, Persia.

Agamodon Peters, 1882

Genotype. Agamodon anguliceps Peters, 1882.

Definition. Snout shovel-shaped. Craniofacial angle pronounced, face laterally strongly produced. Nostrils inferior. Parietal keel very high and sharp. Two large, produced, head shields. Rostral on the edge of the snout. Preanal pores.

Distribution. Italian Somaliland; Arabia.

Subfamily †Crythiosaurinae, subfam. nov.

Pterygoids ventral to the basal plate, reaching the occipital region. Dentition pleurodont. Lower jaw of normal lacertilian appearance. One large parietal shield.

†*Crythiosaurus* Gilmore, 1943

Genotype. †*Crythiosaurus mongoliensis* Gilmore, 1943.

Definition. Only genus in the subfamily.

Distribution. Oligocene of Inner Mongolia.

Incertae sedis

†*Platyrhachis* Cope, 1878

Genotype. †*Platyrhachis coloradoensis* Cope, 1878.

Distribution. Oligocene of western United States.

†*Omoiotyphlops* de Rochebrune, 1884

Genotype. †*Omoiotyphlops priscus* de Rochebrune, 1884.

Distribution. Eocene of France.

†"*Glyptosaurus*" *anceps* Marsh, 1871

Distribution. Middle Eocene of western United States.

Key to the Recent Subfamilies

1	Dentition acrodont	Trogonophinae
1'	Pleurodont	2
2(1')	Snout shovel-shaped, with sharp horizontal edge, not formed by the rostral	Rhineurinae
2'	Snout rounded or laterally compressed	Amphisbaeninae

Key to the Amphisbaeninae

1	No unpaired shield on top of the head except the rostral	2
1'	One unpaired shield behind the rostral	13
2(1)	Infralabials fused and/or nasal fused to first labial, or still more extensive fusions of anterior head-shields	3
2'	Not So	5
3(2)	Ventral segments fused on the mid-line and extensively on the sides	*Placogaster*
3'	Not So	4
4(3')	Quadrate with post-pterygoid process	*Chirindia*
4'	Not So	*Cynisca*
5(2')	Nasals meeting on the mid-line	6
5'	Not So	8
6(5)	A transverse row of four prefrontals	*Shrevea*
6'	Only two prefontals	7
7(6')	Three pairs of large shields behind the rostral	*Amphisbaena*
7'	Four pairs (third sometimes fused)	*Loveridgea*
8(5')	Snout produced into a large keel	9
8'	Snout compressed but not raised into a keel	11
9(8)	Prefrontals elongate, lying alongside the rostral	*Anopsibaena*
9'	Prefrontals very small or indistinguishable	10
10(9')	Posterior margin of rostral vertical	*Ancylocranium*
10'	Irregular	*Baikia*

11(8')	Prefrontals meeting normally on the mid-line	12
11'	Prefrontals very elongate, lying alongside the rostral and barely touching each other behind it	*Mesobaena*
12(11)	Rostral narrow on top; five premaxillary teeth	*Diphalus*
12'	Rostral broad on top; seven premaxillary teeth	*Bronia*
13(1')	Unpaired shield in broad contact with the rostral	14
13'	Not in contact	16
14(13)	Snout rounded	15
14'	Snout pointed or raised into a keel	*Cadea*
15(14)	Anterior limbs present	*Bipes*
15'	Not So	*Blanus*
16(13')	Pectoral shields normal	*Cynisca*
16'	Modified	*Geocalamus*

Key to the Recent Rhineurinae

1	Upper head shields paired	*Aulura*
1'	At least one large unpaired shield	2
2(1')	Only one or two large shields on top of head	3
2'	Several	4
3(2)	Tail normal	*Monopeltis*
3'	Tail ending in a callous pad	*Tomuropeltis*
4(2')	Tail normal	*Leposternon*
4'	Tail with dorsal rows of tubercles	*Rhineura*

Key to the Trogonophinae

1	Preanal pores	2
1'	No preanal pores	*Trogonophis*
2(1)	Only two large, produced shields on top of head	*Agamodon*
2'	Several	*Pachycalamus*

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Observation on Habits of the Cuban Iguana*

By Mario S. Buide

The Cuban Iguana (*Cyclura macleayi*) is a very agile and extremely wary animal, more dependent upon its vision than upon sound for protection. It generally catches sight of possible enemies before being seen. When off guard, as in eating or while sunning itself, it may be surprised, if one approaches carefully; but once alarmed and on guard, it cannot be approached successfully.

In its departure from threatened danger this reptile almost never covers the entire distance to its hiding place in one dash, unless absolutely forced to do so. Usually it advances or withdraws in short spurts of fifteen or twenty yards, poising then like a dog on the alert, listening for any sound. It stretches the neck upward and bobs its head in a rhythmical and comical movement. When it again scents or sights danger, it makes another dash of similar length, and so on until it reaches its hiding place, which in general is a hole or pocket in the rocks. Here it hastens to take refuge and settles down in fancied security. If the hunter finds it in a rather shallow hiding place not affording complete concealment, the Iguana opens its mouth in threatening fashion and gives voice to a disconcerting hoarse noise.

The mobility and agility of this lizard is astonishing to one who has only seen it traveling at ease, with no cause for fright or alarm. It then seems heavy and slothful dragging its belly along the ground and leaving a track or furrow formed by the long, heavy tail. It is so agile, however, that with a few strides it can climb up a twenty-five foot stone wall or a tall tree, which it often does to satisfy its appetite. When surprised aloft it makes a single leap to the ground, and then sets out at high speed.

Unlike most Cuban reptiles, which are active during the hours of darkness, the Iguana, like a few other lizards as the 'Chameleon' and 'Bayoya,' is active during the middle of the day, when the sun is highest. Rarely is it seen before nine o'clock in the morning or after five in the afternoon. If found at such times, it is slow and lethargic. On cloudy or rainy days, it is not seen.

The Iguana may live in areas which completely lack water for drinking even in pits or hollows that might collect rainwater. It is found also on very small areas of land, such as keys and tiny islands. Fishermen from regions of numerous small islands tell me that they have seen the Iguana moving from key to key, crossing narrows of moer than two hundred yards in width by swimming on the surface with the tail employed in the manner of a sculling oar.

The Iguana is an animal that prefers a solitary life, never being found naturally in groups; however, it tolerates collective life when constrained to live so. I keep large numbers together and have never witnessed a single fight amongst them. On cool nights they even huddle together presumably for the purpose of warmth conservation.

Cyclura macleayi reaches a very considerable size; I have had specimens up to 60 inches in length. In these lizards the tail is a most important organ, from the standpoint both of health and resistance. A fat tail on either a young or old specimen is a sign of good health, and that the individual can endure long enclosure and long voyages. However, the tip of the tail is so fragile that it will readily break off in the grip of the incautious handler. The teeth are small and sharp, the bite powerful enough to crush small bones.

The Iguana is omnivorous, eating fruits, vegetables, and ripe bananas, varied in captivity with left-overs from the table such as cereals, meat, and fish. — Ave. 7, No. 354, Cardenas, Cuba.

* English translation courtesy of Dr. D. F. Munro.

Distinctions Between the Snake Genera Contia and Eirenis

By William H. Stickel

The genus *Contia* of Boulenger (1894) was essentially a catch-all for various small snakes that resemble each other in external characters. Boulenger himself would have allocated some of the species differently had he been able to examine the teeth more adequately. His arrangement was not accepted by Cope and never became popular in this country. Among the genera separated from Boulenger's *Contia* are *Opheodrys, Sonora, Chionactis, Conopsis,* and *Pseudoficimia.* The only species commonly included in *Contia* in recent years are the Nearctic *Contia tenuis* (the genotype) and a group of species of Western Asia. In 1914 Barbour proposed, presumably on geographic grounds, to use the name *Eirenis* of Jan (1863) for the Old World species. Schmidt (1939) followed this proposal without comment in using *Eirenis* (type species *collaris*) for several forms. Bogert (1940) also suspected that Barbour was correct, but did not investigate the question.

European herpetologists have generally called the Old World forms *Contia* rather than *Eirenis.* M. A. Smith (1943), in his invaluable work on the serpents of British India, used the name *Contia* for species of this region. He probably did so because no concrete evidence has been advanced to show that *Contia* and *Eirenis* are generically separable. Data in the present paper indicate that these genera are not only separable but unrelated, and that their combination is as unnatural morphologically as it is zoogeographically. Since little has been published on these snakes, and specimens are not readily available to most workers, descriptions of jaws and hemipenes are given in some detail.

Specimens of *Contia tenuis* examined were Museum of Vertebrate Zoology numbers 15983 and 26269, and U. S. Biological Survey 6552. Specimens of *Eirenis modesta* examined were Museum of Comparative Zoology numbers 29029, 31950, 38522, 37005, 37006. The first 3 MCZ specimens are from Mytilene, the last 2 from Samos. Mytilene and Samos are islands in the Aegean Sea just west of Turkey. All specimens listed are males.

Use of insular specimens of a non-genotypic species to represent *Eirenis* is open to question. However, specimens from the 2 islands agree excellently, and since both islands are much closer to the mainland than to each other it is reasonably probable that the specimens resemble the mainland form. And although *modesta* is not the genotype, it is so closely related to *Collaris* that it is questionably distinct and was long considered synonymous (see Boulenger 1913 and Schmidt 1939).

External characters reveal few differences. Number and arrangement of head scales are similar in both genera, and shapes of head scales are not strikingly different. Numbers of scale rows, ventrals, and caudals show no differences of generic magnitude, and furthermore are subject to wide variation in forms of *Eirenis.* Scale pits are single and apical in *tenuis.* They are indistinct in *modesta,* but when present are single and apical.

Jaws and Teeth

Maxillary, ectopterygoid, palatine, and pterygoid bones afford many characters and can be removed without damaging a specimen for other study. More extensive anatomical study is desirable, of course, but is not always feasible or

necessary. Specimens of which the jaws were chiefly compared were USBS 6552 (*tenuis*) and MCZ 37005 (*modesta*). Findings were confirmed or modified by inspection of other specimens.

Teeth and jaws of the two species show no particular resemblance, other than that to be expected in rather generalized snakes of the same family. They differ widely in aspect and considerably in detail. No single difference is proof of lack of close relationship, but inasmuch as there are no special similarities the total of distinctions seems highly significant. Some of the more convincing differences are italicized in the comparison that follows.

Contia tenuis	*Eirenis modesta*
Bones slender, of little depth.	Bones sturdy, deep.
Maxillary ending posteriorly at its ectopterygoid process.	Maxillary bearing one tooth posterior to its ectopterygoid process.
Palatine without maxillary process, anterior end plain, only slightly and gradually widened.	*Palatine with strong maxillary process,* and extending anteriorly beyond this process.
Ectopterygoid not forked (anterior end with inner branch lacking).	*Ectopterygoid forked,* with strong outer and more slender inner branch.
Ectopterygoid much longer (the main differences in the pterygoid are correlated with this).	*Ectopterygoid much shorter, heavier.*
Pterygoid with bulge for reception of ectopterygoid at 1/2 the length of the pterygoid.	Pterygoid with this bulge at 1/3 its length.
Pterygoid with slender anterior portion comprising 1/2 *its length.* The rest lightly reinforced.	*Pterygoid with slender anterior portion comprising* 1/5 *its length.* The rest heavily reinforced and flanged.
Pterygoid not toothed posterior to ectopterygoid.	Pterygoid bearing 6 teeth posterior to ectopterygoid.
Teeth much longer, their length greater than depth of bones bearing them (except for posterior pterygoid teeth).	Teeth shorter, their length less than depth of bones bearing them.
Teeth sharp, conical, recurved. Tooth sockets weak and shallow, hard to see.	Teeth with tips slightly flattened antero-posteriorly, less recurved. Tooth sockets well defined.
Maxillary teeth about equal except that last is smallest.	Maxillary teeth increasing slightly in size from front to rear.
Palatine and pterygoid teeth anteriorly almost equal to those of maxillary, but gradually decreasing posteriorly.	Palatine and pterygoid teeth all about equal to each other and to those of maxillary.
Maxillary teeth 11; palatine 7 (+1?); pterygoid 12; dentary 14 (possibly plus 1 or 2 small posterior teeth).	*Maxillary teeth* 18; palatine 9; pterygoid 17.

Hemipenis of *Contia tenuis*

The following description is based on all three specimens, with data on details chiefly from the USBS specimen. The other two agree in fundamentals but may differ slightly in numerical details.

The penis is 7 caudals long in the three specimens. Externally the organ and its main retractor muscle are simple. Internally the penis is slightly bilobed at the very apex. The sulcus is forked near the end. The forked portion is a little less than one caudal in length and both branches end on one of the above mentioned lobes; i. e., the branches do not run to the 2 lobes. The tip of the organ is calyculate for the length of 1.5 caudals.

The rest of the organ bears spiniferous, longitudinal ridges. These fleshy ridges tend to coalesce, divide, and terminate irregularly, making them difficult to count. At the base there are about 6. Halfway between base and calyces there are about 10 ridges plus 2 heavy ones fused to the lips of the sulcus. Opposite the sulcus are 2 adjacent ridges thicker than those beside them. All ridges bear spines. Basally the spines are very small (spinules) but opposite the second caudal fairly large spines abruptly appear and continue caudad, diminishing in size. Each of the smaller ridges bears 4 to 6 (usually 5) spines along its length (disregarding basal spinules). The ridges along the sulcus and the 2 heavy ones opposite them each bear two rows of spines. There are also spines between the 2 heavy ridges opposite the sulcus. It is scarcely feasible to count the spines, but there are roughly 80 on the penis, not counting the several basal spinules. Each spine has a small projecting tip, an expanded mid-portion, and a more slender straight base. There is a curve between each of these parts, making the tip parallel to the base, but offset.

Distally the ridges anastomose to form calyces. The calyces are rather simple and weak with low, rounded lobes. There are about 4 or 5 rows of calyces. They become small distally, but cover the apex. There are a few calyces in the fork of the sulcus.

An idea of the appearance of this hemipenis can be gained from Cope's figure for *Carphophis* (1900, pl. 23, fig. 6). The chief difference is that the sulcus of *Contia* is forked for relatively less of its length. There are, of course, less evident differences not shown by Cope's drawing. Inspection of a specimen of *Carphophis* reveals that Cope's figure is adequately representative of this genus. As I have previously pointed out (1943), Cope's illustration of the hemipenis of *Contia tenuis* is in error, and may have been based on a specimen of *Sonora*.

Hemipenis of *Eirenis modesta*

Based on the 5 MCZ specimens previously listed. Variations mentioned do not appear to be correlated with island of origin.

The penis extends to caudals 12 (in one specimen), 13 (in one), or 14 (in three). The organ and its main retractor muscle are simple, unforked. The sulcus also is unforked. It enters ventromesially, runs straight to the top and curves over onto the apex.

At the base of the penis and extending to (or nearly to) the anal plate is a group of large spines. The group consists of 4 to 9 large spines, and is accompanied by a small spine in two specimens. There are 4 large spines in two specimens, 7 in two, 9 in one. Where there are 7 or 9 spines they are in two rows. This group is adjacent to the sulcus. On the other side there is a gap

between the shafts of these spines and the sulcus. Distal to this gap and opposite the bases of the large spines is a group of 3 to 5 medium sized spines (recorded as small in one specimen). There are then 5 to 7 crowded rows of small spines that diminish in size distally and are sharply replaced by calyces. All spines are essentially straight and are invested by fleshy sheaths from which the tips of the spines may protrude.

Calyces cover a little more than half of the organ. They are largest basally, diminish in size distally, and tend to degenerate apically. Each calyx has 1 to 4 (usually 3) pointed lobes.

The most striking feature of the penis is a forked invagination of the penial wall. On the outer surface of the penis is a slit ,which when opened reveals two deep, linear pockets. On the inner surface of the penis the invagination appears as a ridge that extends the length of the calyculate area. The ridge is single proximally, but soon branches into two parallel, closely appressed ridges. When parted, these branches are seen to be separated by thin, acalyculate to feebly calyculate tissue. The ridges are covered by densely massed calyces, which suggests that the ridges are distended when the organ is everted. In one specimen, possibly abnormal, the ridge is not forked and there is no thin tissue beside it.

For comparison we may quote M. A. Smith's description (1943) of the hemipenis of the supposedly congeneric *"Contia persica:"*

"Hemipenis extending to the 13th caudal plate, not forked; there are spines throughout, those at the extreme base being a little larger than the others. Extending nearly the whole length of the organ there is a conspicuous fold."

The presence of a fold may be a significant similarity, but the absence of calyces in Smith's specimen suggests that the relationship between *Eirenis modesta* and *Eirenis persica* is far from close.

Discussion

The many differences between *C. tenuis* and *E. modesta* in characters of jaws and hemipenes certainly indicate that they are not congeneric. I have observed no similarities that suggest that they are closely related. No doubt these genera belong in different tribes; eventually they may be placed in separate subfamilies, if these can ever be distinguished satisfactorily in the Colubridae.

The taxonomic arrangement remains as treated by various recent workers, with the name *Contia* restricted to *tenius* and the name *Eirenis* used for Old World forms related to *modesta* and *collaris. Eirenis* may not be a wholly natural group, but it is unlikely that any segregate genus will prove to be related to *Contia.*

The relationships of *Eirenis* seem clear. M. A. Smith says of this genus: "Dwarfed, degenerate snakes, closely resembling the Oriental *Liopeltis,* from which, except for the presence of apical pits, they are generically indistinguishable." Smith believes *Liopeltis, Eirenis,* and *Opheodrys* to be closely related to and derived from the racer group (*Ptyas, Coluber, Zaocys* and others). This conclusion may well be correct in view of what is known of the ramifications of the racers and their derivatives. A bit of supporting evidence may be added from a comparison of jaws of *E. modesta* and *Coluber constrictor.* They are enough alike to have come from snakes of the same genus. There are but slight proportional differences, the chief ones being that in *modesta* the teeth are stubbier, the maxillary a little deeper, and the posterior end of the pterygoid longer. They agree perfectly in several details.

Smith may be correct in assigning *Lytorhynchus* to this same group of genera, for Bogert (1940) also places it near *Coluber,* but Smith is probably wrong in stating that, "*Lytorhynchus* is closely related to the American *Phyllorhynchus* . . . " These snakes differ in several respects, including condition of sulcus. It is likely that they evolved separately in their respective desert areas, and from quite different ancestors. The oft-repeated idea that *Phyllorhynchus* is related to the racer group has no basis in fact, as Bogert and Oliver (1945) have pointed out. Actually, its relationships are entirely unknown, like those of some other North American genera having hemipenes with calyces and forked sulcus.

Contia is one of these genera. It has commonly been considered related to or even congeneric with *Sonora.* The bases of this idea were external similarity of the snakes and Cope's erroneous use of a *Sonora*-like hemipenis for his illustration of *Contia.* The hemipenis of *Sonora* does not have a forked sulcus and differs from that of *Contia* in enough other details that no close relationship is to be suspected. Teeth and jaws are widely different. In *Sonora* the posterior maxillary teeth are enlarged, grooved, and flanged. The maxillary bone is deep anteriorly, and posteriorly projects past (and bears 2 teeth beyond) its ectopterygoid process. The ectopterygoid is bifurcate and much shorter. The anterior end of the palatine is expanded, providing a maxillary process and a longitudinal tunnel for a large blood vessel. None of these features is seen in *Contia.* The pterygoids are very dissimilar in shape, partly because of the greater length of the ectopterygoid in *Contia.* The narrowed anterior part of the pterygoid is longer (bearing 9 teeth) in *Contia* and much shorter (bearing 3 teeth) in *Sonora.* The pterygoid is not toothed posterior to the ectopterygoid bone in *Contia,* but bears 7-8 teeth beyond this point in *Sonora.* The most important of these features are perhaps the maxillary dentition and the condition of the palatine. Many less tangible differences are not mentioned.

It seems evident that *Contia* and *Sonora* are not related and that they are at least tribally distinct. As with *Contia* and *Eirenis,* the resemblances in external morphology are simply the result of parrallelism, with rather generalized colubrids being at a similar level of scutellation development—a level that represents a fairly stable and relatively unspecialized stage in the reductional sequence. This level, though not strongly specialized, must be adaptive, for it includes many genera of different origins but similar physiognomy. Some of these genera (e. g. *Eirenis*) still show evidence of derivation from widespread stocks. *Sonora,* on the other hand, has no known ancestral stock but is itself the generalized member of a complex of fossorially adapted genera.

No such statements can be made about *Contia.* It stands very much alone. Some workers have suggested that its geographic position indicates probable relationship with an Eastern Asiatic group. This may yet prove true, but I know of no Asiatic genus to which it is allied. Furthermore, the habitat of *Contia* is a very ancient one, and animals from many areas have had chances to enter it.

The hemipenis of *Contia* is of xenodontine type, but the phyletic significance of this fact is uncertain. Bogert (1940) demonstrated that the condition of the sulcus is by no means a subfamily character in African snakes. On the contrary, forking of the sulcus appears to be a primitive condition from which unforked sulcus has developed independently in various groups. H. M. Smith (1942) pointed out an example of this in a group of American snakes. There seems to be little doubt at present that the principle has wide application, and that the subfamily Xenodontinae is a more or less unnatural group.

If this is true, there is no reason to think that all of our North American snakes with xenodontine hemipenes are of the South American faunal element. Some of them (*Coniophanes, Rhadinaea*) probably are of this fauna, for they can be traced directly to groups in tropical America. Some of our other genera with xenodontine hemipenes have no demonstrable relatives to the south, and once their supposed xenodontine relationships are questioned they appear isolated indeed. Certain of these genera are ecologically and morphologically specialized to a high degree. It seems likely that they are not of South American origin, but that they are relatively ancient forms that may have been on this continent as long as or longer than the Old Northerners. Their forked sulcus and isolated positions suggest age. Their near relatives may have become extinct, or may have evolved along such different lines that they are no longer recognizable as relatives.

Genera to be considered in this connection are *Carphophis, Abastor, Farancia, Diadophis, Heterodon, Phyllorhynchus,* and *Contia.* Possibly some of these can be shown to have relatives in the South American fauna, but that in itself would not be proof that all of them were derived from that fauna. Some may have been, but it is doubtful that all were.

At the suggestion of Mr. C. M. Bogert, certain structures of *Contia* were compared with those of *Diadophis.* The hemipenis and its sulcus are rather deeply bifurcate in *Diadophis,* and the branches of the sulcus run to the 2 lobes of the hemipenis. The jaws of *Diadophis* are much nearer the colubrid norm than are those of *Contia.* These structures thus yield no evidence of close relationship. If we assume, however, that the trend in *Contia* has been toward a less xenodontine type of penis (as it appears to have been, and as it is in genera studied by Bogert and Smith), and that peculiarities of the jaws of *Contia* are specializations of its own, we conclude that the progenitor of *Contia* could have been much like *Diadophis* in respect to jaws and hemipenis. Relationship between these genera is therefore possible but by no means proven.

The phyletic and faunal relationships of *Contia,* then, are as uncertain as ever. All that can be said at present is that *Contia* is a distinct monotypic genus; that it may be of greater age than many of our other colubrid genera; and that its ancestors probably had more bifurcate hemipenes and less peculiar jaw structure.

Acknowledgments

I am grateful to Mr. Charles M. Bogert of the American Museum of Natural History for his kindness in reviewing the manuscript, and to Mr. Arthur Loveridge of the Museum of Comparative Zoology and Dr. Alden H. Miller of the Museum of Vertebrate Zoology for their courtesy in lending specimens for study.

Summary

Various workers have believed *Contia* to be related to or congeneric with either or both *Sonora* and *Eirenis,* the latter a genus of Western Asia. Study of hemipenes, teeth, and jaws indicates that these genera are not related to one another.

The hemipenes of *Eirenis modesta* and *Contia tenuis* are described.

Eirenis is thought to be a derivative of the racer group.

Relationships of *Contia* are unknown.

It is suggested that some North American genera with xenodontine-type hemipenes may not be of the South American faunal element and may have been in North America at least as long as the Old Northerners.

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—Patuxent Research Refuge, Laurel, Maryland.

A FURTHER NOTE ON HEAD BOBBING IN SNAKES—Wilfred T. Neill has reported rather extensively (1949, Herpetologica 5: 114-115) on the head bobbing habit in various snakes. Although he mentions several species of *Elaphe* as exhibiting this habit, he makes no mention of *Elaphe o. quadrivittata.*

Recently, a freshly captured *Elaphe o. obsoleta* was placed in a cage with two yellow rat snakes, *Elaphe o. quadrivittata.* Although the larger one showed no interest in the new specimen, the smaller one became uneasy. As the *E. o. obsoleta* approached this specimen, it stopped short and raised the head and some three inches of the body above the cage floor. The *E. o. quadrivittata* did likewise and the two snakes bobbed some three or four times at each other. The performance ended with the *E. quadrivittata* striking at the *E. o. obsoleta.* It fell short of its mark, probably because it was in the stage of cloudy spectacle prior to ecdysis. No further demonstrations have been observed.

—J. M. Mehrtens, 74 Eldert St., New York City

THE "PLAYING POSSUM" HABITS OF THE RINGHALS COBRA. — During a recent visit with my good friend, Gerry E. S. Tordt, at his well known "El Paso Reptile Garden" I had an opportunity to observe three Ringhals (Dutch for Ring Neck) spitting "Cobras." Dentition and scalation differences indicate that these are Elaphines, although not "true cobras."

Under observation, two of these specimens liberally sprayed the glass fronted cage with venom, while a third remained in seclusion in the box that it had occupied since its arrival. Gerry Tordt opened the box containing this third specimen and it immediately exhibited extreme nervousness by darting about the cage in an extremely rapid and apparently confused fashion. Shortly after its removal from the cage, it went into convulsions, biting another of the Ringhals and apparently dying. It lay on its back with its head under water in the water pond. I immediately informed Gerry Tordt that one of his Ringhals was "dead.' Tordt started to remove the snake from the cage when he suddenly remembered that some of the Elaphines sometimes react in the manner generally known to be characteristic of the Genus "Heterodon," and decided to await results.

He removed the snake from the water whereupon it immediately thrashed convulsively about with mouth open and tongue limply extended, thereby gathering considerable sand in the mouth. Tordt washed the mouth and laid the snake down. No respiration was noted for approximately thirty minutes when breathing was again apparent. The tail moved slowly several times. Within several hours the snake was very active, spreading a beautiful hood and spraying at the glass. This same specimen, however, soon returned to the box that had been its refuge since its arrival.

It is apparent that the so called "playing dead" of some species would serve no purpose to save the snake from any predatory animal, so, why does this "playing possum" occur?

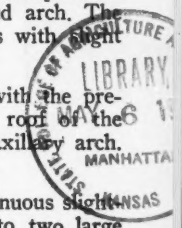
It is this writers opinion that certain specimens actually "faint" due to a nervous condition. It is to be noted that the captive specimens of the genus "Heterodon" that tend to be well acclimated to their environment show less tendency to perform in the manner noted above. I have noted similar "playing dead" among other genera. — Jon H. Hulme, c/o Simpson, Star Route, Mary Esther, Florida.

A HIGH BIRTH RATE FOR *NATRIX SIPEDON SIPEDON* (Linne). —Although water snakes are known to be exceedingly prolific, a specimen of *Natrix sipedon sipedon* (Linne) received for exhibition purposes by the Steinhart Aquarium, San Francisco, in September 1950, shortly after its arrival gave birth to ninety-nine young; forty-two males, fifty-six females and one sex not determined. This is believed to be a record brood, considerably above that given by Fowler (Copeia No. 19, p. 15, 1915), who reported a brood of seventy-six. —Joseph R. Slevin, California Academy of Sciences, San Francisco, California

Teeth of Salamanders

By William A. Hilton

In general the areas are maxillary with the premaxillary of the upper jaw, mandibular and in the roof of the mouth vomerine and palatine, somtimes vomero-palatine. In addition in *Siren, Pseudobranchus* and rarely in some others there may be horny ridges in place of or in addition to teeth in the forward part of the jaws. Each of the usual teeth is of two regions, the crown above the mucous membrane of the mouth and the socket portion below. Each of these has enamel on its exposed surface which is often of a light yellowish color and in smaller teeth very often two pointed at the end, with one of the points sometimes at a sharp angle with the line of the other. The main substance of the tooth is dentine surrounding the pulp cavity. In Proteidae a semicircular patch of teeth on the upper jaw is followed by more extensive caudal one which is interrupted on each side in *Necturus* but in *Proteus* appears as a single elongated arch. The arrangement in larvae of many forms is like Necturus or Proteus with slight differences in position and extent of the teeth patches.



In *Amphiuma* the teeth of the upper jaw form a large arch with the premaxillary teeth only slightly separated from the maxillary. In the roof of the mouth a marked arch of teeth is parallel with the maxillary-premaxillary arch. The teeth are quite large, conical. I did not find any with two points.

In Cryptobranchidae in addition to the jaw teeth there is a continuous slightly arched band between the internal nares. In Siren in addition to two large patches of teeth in the forward part of the mouth, each jaw has a horny ridge at the front. *Pseudobranchus* has similar horny plates which are much smaller. Teeth in the roof of the mouth form one patch on each side.

In Hynobiidae the two genera examined, have in addition to the jaw teeth, a patch under each internal nasal opening, this patch is first at nearly right angles to the body axis and then bends and extends backwards. This I found in *Hynobius* and *Salamandrella.* In several other genera there was a small vomerine patch on either side back of the internal nasal opening and no backward extension.

In Salamandrae in addition to the jaw teeth there was usually a long straight or arched patch or row from near the internal nasal opening on each side well back onto the parasphenoid. I found this to be the case in all species of *Triturus* both old and new world in *Cynops, Euproctus, Pleurodellides,* and *Salamandra.* In Ambystomidae the usual condition was a line of teeth patches across the roof of the mouth just back of the internal nares. There might be three or four of these patches depending upon the division of the central one. In Plethodontidae, in addition to the teeth of the jaws, there are usually under each internal nasal opening on the roof of the mouth, a small vomerine patch and two or one parasphenoid patches. Sometimes the vomerine patch is lacking, sometimes the teeth are more in rows than patches, sometimes the vomerine are continuous with parasphenoid. There is considerable variation in the group with these and other points. In *Desmognathus* frequently there are no vomerine patches. In some, such as *Batrachoseps* the praasphenoid patches may appear as one.

Two interesting variations from the usual condition were noted as follows:

An adult and otherwise usual *Necturus* had a horny plate at the tip of the lower jaw, such as found in *Siren.*

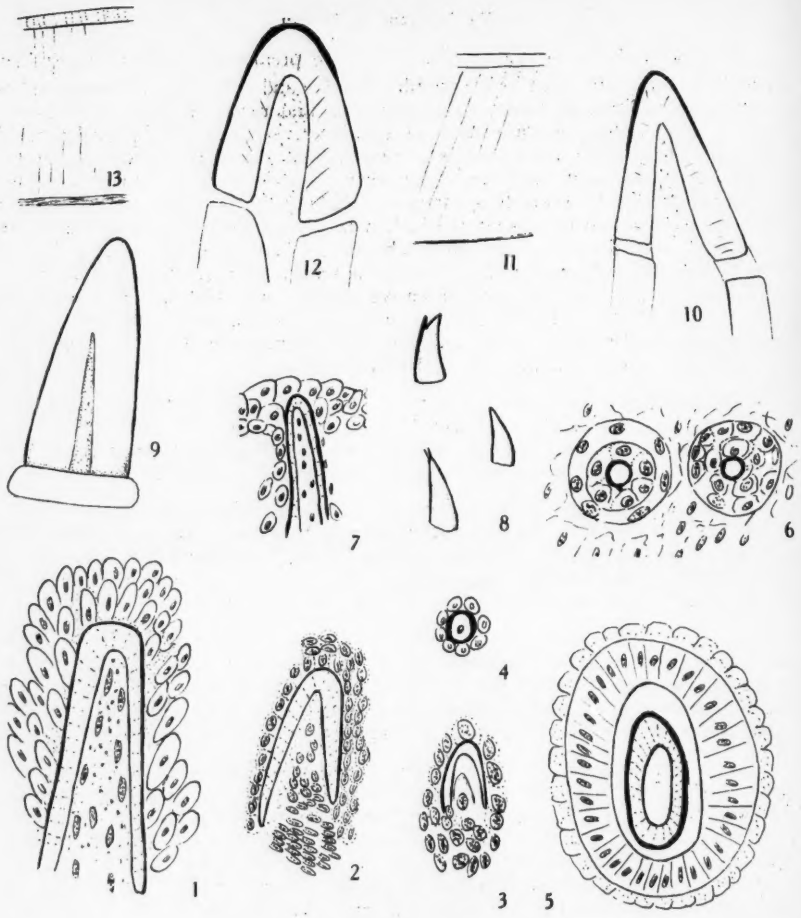


Figure 1. 1. Tooth of Pseudobranchus inclosed in cells. 2. Section of developing tooth of Triturus viridescens. 3. Developing tooth of Necturus larva. 4. Section of developing tooth of Ambystoma maculatum of 14 mm. length, cut across. 5. Cross section of developing tooth of adult Plethodon glutinosus with enamel producing cells and enamel on the tooth. 6. Section of developing tooth of Desmognathus. 7. Longitudinal section of developing tooth of Ambystoma maculatum of 16 mm. 8. Small jaw teeth from adult Plethodon. 9. Tooth of jaw from Anneides lugubris. 10. Section of tooth of adult but small Amphiuma. 11. Section of dentine and enamel of the last enlarged. 12. Section of tooth of adult Necturus. 13. Section of enamel and dentine of the last.

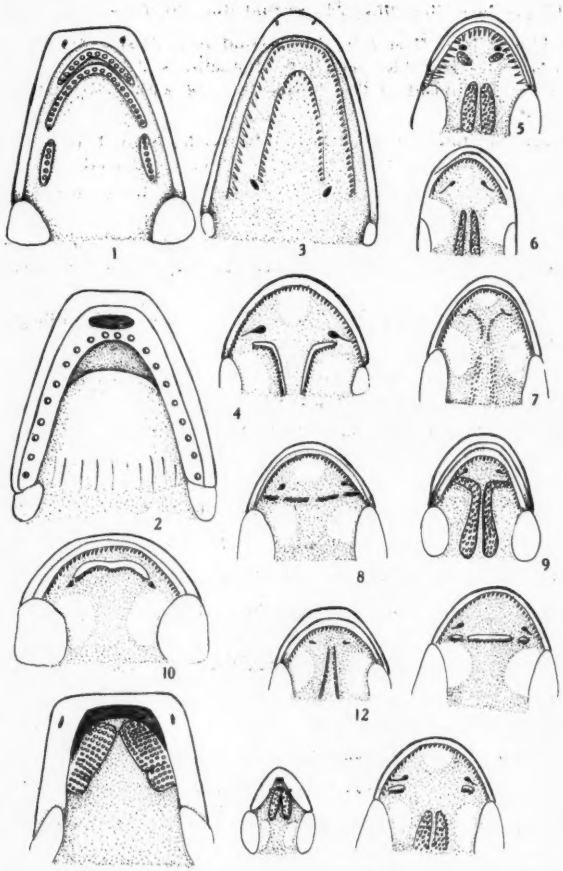


Figure 2. All but 2 are upper jaws and teeth of salamanders. 2. is lower jaw region of Necturus, showing horny plate deeply shaded. All are adults. 1. Necturus. 2. Necturus, lower jaw region. 3. Amphiuma. 4. Salamandrella. 5. Aneides. 6. Desmognathus. 7. Eurecea. 8. Ambystoma tigranum. 9. Gyrinophilus. 10. Cryptobranchus. 11. Siren. 12. Triturus viridescens. 13. Rhyacotriton, usual condition. 14. Pseudobranchus. 15. Rhyacotriton, unusual condition with patches of parasphenoid teeth.

A single adult *Rhyacotriton* was found with parasphenoid teeth like those quite characteristic of the Plethodontidae. The number of teeth in some specimens was as follows (The total number will be given for each jaw and the number in separate patches, unless otherwise stated)

Proteus—Upper jaw, first line, 24; second line, 50. Lower jaw, 50.

Necturus—Upper jaw, first row, 12; second row, first part, 22; second division of the last on each side, each 7-8 (Sometimes this makes a continuous line with the others ahead of it). Lower jaw, 24 with 6 separate on each side at the caudal end.

Cryptobranchus (adult)—Upper jaw, 110 teeth; second row between internal nares, 52. Lower jaw, 110. (Larva of 35 mm., 30 teeth on lower jaw.)

Amphiuma (adult)—Upper jaw, first row, 60 (the premaxillary has 10 of these); second row, 50. Lower jaw, 50.

Siren (young)—Upper jaw, large patch on each side, 55; smaller patch, 6. Lower jaw patch, 60. *Siren* (larger)—Upper jaw large area, 55; smaller upper jaw patch, 25.

Salamandrella—Premaxillary, 17; maxillary, 26; madible (single), 16; vomerine, 19.

Ambystoma tigrinum (adult)—Upper jaw, 56; lower, 56; vomer, 21.

Dicamptodon—Upper and lower jaws, 88; vomer, 18.

Rhyacotriton (adult)—Upper jaw, 110; lower, 140; vomer, 20. *Rhyacotriton* (larva)—Premaxillary, 30; maxillary, 30; vomerine, 30; palatine, 22; total lower jaw, 120.

Salamandra maculosa—Premaxillary, 18; maxillary, 30; vomer, 25.

Pleurodellides—Premaxillary, 10; maxillary, 25; lower jaw total, 80.

Triturus vulgaris—Premaxillary, 14; maxillary, 24; lower jaw, 36 on a side.

Triturus granulosus mazamae—Premaxillary, 15; maxillary, 40; one half the lower jaw, 60.

Triturus t. torosus—Premaxillary, 14; maxillary, 24; vomer, 38; one side lower jaw, 36.

T. viridescens (adult)—Premaxillary, 12; maxillary, 22; vomer, 25.

T. alpestris—Premaxillary, 20; maxillary, 28; vomer, 28.

Eurpoctus—Premaxillary 10; maxillary, 25; one half lower jaw, 40.

Plethodon glutinosus—Upper jaw, 60; vomerine, 11; parasphenoid, 160 in each patch.

Eurycea bislineata—Premaxillary, 8; maxillary, 15; vomerine, 8; parasphenoid, each patch, 40.

Boletoglossa leprosa—Premaxillary, 4; maxillary, 26; vomerine, 4; parasphenoid, 63.

Plethopsis (Batrachoseps)—Premaxillary,6; maxillary, 26; vomerine, 9; parasphenoid, one side, 63.

Aneides lugubris—Premaxillary, 6; maxillary, 7; vomerine, 6; parasphenoid, one side, 100.

—Dept. Zoology, Pomona College, California

THE RHODESIAN GRASS SNAKE. — The Striped Grass Snake, *Trimerorhinus triaeniatus* is locally called Schaafsteker because it is supposed to strike sheep, but there is no evidence to support this belief.

This species is back fanged. The fangs are short and the snake is usually considered harmless. Most case of bites on fingers or foot pass off with little or no sign of poisoning. Severe poisoning may follow if the snake is allowed to hold on and worry after the initial bite. Fitzsimmons says that his analysis of this snake's poison, shows it to be more deadly, bulk for bulk, than that of the more-feared boomslang and that a prolonged bite might bring death to a man in six hours.

In ordinary circumstances it is considered a useful and harmless snake. When discovered, it retreats to thick grass or under leafy cover and lies very still. It may even be picked up without any violent reaction if calmly dealt with.

It feeds on small mammals, mice and shrews, occasional birds, big insects and lizards. The Brown Skink shown in the illustrations is the commonest of all local lizards, occurring in every type of country. — W. T. Miller, Bulawayo, Southern Rhodesia.

A Rana catesbeiana with Six Functional Legs

By John L. Pelgen

This unusual bullfrog was taken in October 1948 near Turlock, California, and was placed in an aquarium in Dr. John Arnold's laboratory at the College of the Pacific where it was observed for two weeks. It was a female in excellent condition and appeared to be two or three years old.

All of the extra appendages except limb 4 (see figure 1.) are functional. The extra appendages all grow from the right side of the body. Limbs 2, 3, and 4 originate from the sternum, while limb 1 would be the normal right fore limb.

Limb 4, which is not functional, has four digits which are partially decomposed at the tips. This is probably due to the fact that there is no muscle connected with the limb and the only apparent blood supply is through the skin.

Figure 1. Ventral side showing numbered limbs and fingers described in text.

Finger 1 is rigidly attached to, or grows out of, the humerus of limb 1. Finger 2 is loosely articulated to the proximal end of limb 4.

With regard to the skeleton, limbs 1 and 4 and fingers 1 and 2 form a unit by themselves. Limb 1 articulates to a glenoid fossa on the deformed coracoid. The junction of the clavicle, coracoid, and scapula form a deformed mass of bone to which limb 4 is attached. The unit is attached to the sternum by a normal clavicle and a deformed coracoid.

The muscle dorsalis scapulae is nearly normal in shape and is inserted where the humeri of limbs 1 and 4 are closest. The latissimus dorsi is extremely reduced and is not inserted but ends in the tissue dorsal to limb 1. The depressor mandibularis is somewhat reduced, but apparently functional. Limb 1 is sparsely muscled and the tissue is almost transparent, evidently receiving a very scant supply of blood. Digits on this limb are decomposed at the tips as on limb 4.

Limb 1 appears to have been the natural limb, although much atrophied. It is articulated to the deformed coracoid by a glenoid fossa.

The unit formed by limbs 2 and 3 is perhaps the most interesting from a developmental standpoint. It may be seen in figure two that this unit bears a striking resemblance to the sternum and fore limbs of normal individuals. This unit is attached to the metasternum. The muscles of these legs are well developed but so distorted from the normal as to be impossible to identify.

The left side of this animal was completely normal in all respects. The deviation from normal occurred from the sternum to the right.

The embryological background of this animal would be impossible to determine with the facts at the author's disposal, but it seems likely that the deformation was caused by mechanical or chemical damage to the embryo during its early developmental stages.

College of the Pacific, Stockton, California

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Figure 2. Dissection showing attachment of the anomalous limbs to the sternum.

NOTES ON LATE SUMMER SNAPPING TURTLE MOVEMENTS. — On several occasions during August, 1947 and 1948, snapping turtles, *Chelydra s. serpentina* were observed in southeastern Iowa, to leave permanent bodies of water and move in seemingly erratic manner. During these observations the movements were largely along dry dusty roadways where their paths of travel were readily recorded. In 1947 seven individuals were noted (four in one day) and in 1948, twelve. During both years, all of these individuals left trails that could be traced to the DesMoines River which flowed within 50 yards of a much traveled road. At right angles to this main route there extended a less traveled road. For no apparent reason, most of these turtles eventually traveled away from the river along this latter route. The greatest distance anyone of them was found from the river approximately 520 yards. Of the 19 specimens observed in the two years, 13 were killed by vehicles.

In August, 1948, a pair of traveling snappers was observed at the edge of a dirt road. Their tracks had led from a nearby pond that was decreasing in size during the summer drouth. For the first 100 yards each member traveled on opposite sides of the road near the edge of the bordering vegetation. One of the pair then crossed over, joined its mate, and the two continued their roadway journey which ended when they entered a large stream. In two and one-half hours the two turtles had covered a distance of 610 yards. On the basis of the time and distance traveled, their speed was calculated at .125 miles per hour. This included two short stops during the trip.

Movements of the turtles seemed to be associated with a drop in water level of their original habitat. However, both the river and the pond were known to be dry only on rare occasions. Possibly, the shrinkage of water area or water depth caused the turtles to seek new habitats.—W. D. Klimstra, Zoology Department, Southern Illinois University, Carbondale, Illinois.

NOTES ON PHRYNOSOMA D. DOUGLASSII IN JEFFERSON COUNTY, OREGON. — On August 2, 1950, one female horned lizard was taken about seventy-five feet from the north shore of Jack Lake, Jefferson County, Oregon, at an altitude of 5,475 feet. This locality is approximately fifteen feet higher than the summit of Sand Mountain, Linn County, Oregon, where thirteen specimens were taken by Graf, Jewett and Gordon (Copeia, 1939:103).

On August 7, 1950, the Jack Lake female (total length, 73 mm.; snout-vent length, 53 mm.) gave birth to seven young. When the young were discovered, a few hours after birth, one had been killed and badly mangled, apparently due to the female stepping on it. The mean total length and standard error of the mean of the remaining six young was 25.3 +- 0.92 and the mean snout-vent length and standard error of the mean was 17.7 +- 0.22.

The habitats of these Cascade mountain specimens are not wholly at variance with the "typical" sandy, rock-covered niche in which this form is usually found. The substrate of minute volcanic rock and pumice plus the larger volcanic rocks found in the Oregon Cascades result in well-drained areas, which seem to be a requirement of this lizard. The altitude at which these Cascade specimens were found and the relative continuity of rocky open areas would perhaps permit this form to be widespread in the high Cascade Mountains. — Richard A. Pimentel, Dept. of Zoology, Oregon State College, Corvallis, Oregon.

Eurycea multiplicata Collected at the Restricted Type Locality

By Richard B. Loomis and Olin L. Webb

The recent restriction of the type locality of the many-ribbed salamander, *Eurycea multiplicata* (Cope) to "near Fort Towson, Choctaw County, Oklahoma" by Dundee (Herp. 6:27-28, 1950), prompted the writers to search the area for this species of salamander. Along a small spring-fed stream flowing through limestone bedrock one-half mile west of the town of Fort Towson, thirty adult *Eurycea multiplicata* were collected on March 25, 1951. Most of the salamanders were found under partly submerged limestone rocks bordering the stream below an old dam. This dam had formed a pond, which probably assures a continuous flow of water, by overflow and seepage, along the lower part of the stream. As many as four adult many-ribbed salamanders were uncovered under a single rock, and frequently two or three were together. On several occasions *multiplicata* were found with small to medium sized tarantulas (*Eurypelma* sp.), but the spiders were always under the upper, drier end of the same rock. Above the pond, where the stream bed was dry except for a few pools, salamander larvae, but no adults, were found. A few adults were found on the banks adjacent to the dry stream bed under large limestone rocks. This was the only species of salamander found at this locality.

Only scattered oak, Osage Orange, and a few cedar trees were found adjacent to the stream, and ground vegetation was practically non-existent. Apparently these conditions resulted from extensive overgrazing and overbrowsing by livestock, and probable lumbering of the original oak forest many years ago. Despite the paucity of vegetation, the spring-fed stream and limestone rocks provided a suitable habitat. Superficial examination of streams three to five miles north of Fort Towson in the oak-pine forest of the Ouachita region failed to reveal any streams suitable as habitat for *multiplicata*. It should be noted that the ruins of the original Fort Towson are approximately one mile east and one-half mile north of the present town, less than two miles from our collecting site. Apparently this is the first report of *multiplicata* from Choctaw County since the types were collected there by Dr. L. A. Edwards in the 1850's.

The descriptions of adult *multiplicata* by Cope (Proc. Acad. Nat. Sci. Philadelphia, 1869, p. 106) and that by Bishop in the Handbook of Salamanders (1943, pp. 435-439) closely fit these specimens except for certain details of coloration. In ten adults total length 66-88, ave. 77.5 mm.; head and body 34-43, ave. 38.9 mm.; tail 32-46, ave. 38.6 mm., measured from tip to posterior end of vent; tail into total length approximately 2 times, if tail complete. The largest specimen measured, a male, with total length of 88 mm., tail 46 mm. Costal grooves 19, including one each in axilla and groin; 21 rib-bearing vertebrae from axis to sacrum inclusive (in three specimens cleared and stained). Intercostal spaces 7-8 between appressed limbs. Vomerine teeth number 6 to 8 on each side and paravomerine "parasphenoid" teeth in two patches, separated by width of a single patch.

In life, general ground color fleshy to yellow; dorsal surface chocolate brown, usually with broad middorsal light yellow-brown band starting on head and tapering to a termination near end of tail, bordered by dark chocolate brown, and with thin interrupted dark vertebral line extending back from head and terminating above anus; thin brown chevron markings following myosepta on light body band of some smaller, lighter individuals; larger, stouter individuals

with more uniformly brown dorsal coloration; silvery flecks over entire brown dorsolateral surface, most abundant laterally; ventral surface without dark pigment, under part of tail and usually posterior half of belly yellow; throat flesh colored, without yellow or dark pigment; thin border of dark pigment present along lower lip.

The availability of other living adults of *multiplicata* from southeastern Oklahoma and southwestern Arkansas affords an opportunity for pattern and color comparison with the Fort Towson topotypes. A series of ten adult *multiplicata* from 5.5 miles west of Idabel, McCurtain County, Oklahoma collected March 24, 1951, closely resemble the topotypes, except that ventrally the yellow is more prominent, extending in patches onto the throat. The similarity would be expected since the habitat is similar to the type locality which is 20 miles west. Three adult *multiplicata* from Rich Mountain;—one from LeFlore County, Oklahoma, collected March 2, 1951, and two specimens from 3 miles northwest of Mena, Polk County, Arkansas, collected March 27, 1951, differ somewhat in pattern and coloration from the topotypes. They are nearly uniform brown dorsally on a yellow ground color, with only slight indications of a light dorsal band. The ventral coloration differs in being uniformly yellow except for the anterior part of the throat which is flesh colored. This bright yellow venter and yellow ground color appears to be constant for Rich Mountain examples. Forty adult *multiplicata* were collected in a stream flowing through sandstone bedrock in oak-pine forest, 7 miles north, 5.5 miles east of Waldron, Scott County, Arkansas, March 3, 1951, in the Ouachita Mountains. The color closely approaches that of the topotypes.

Comparisons between living samples of populations of *multiplicata* from the Ouachita Mountains and the limestone areas just to the south, indicate that they are strikingly similar in color and pattern. Color differences are present in individuals from Rich Mountain. They have a yellow ground color, including more extensive yellow on the venter and a more uniformly yellow-brown dorsum.

After careful examination of the information supplied by Dundee (*loc. cit.* and verbal) and on the basis of collecting *multiplicata* from the area he proposed as the restricted type locality, we feel that he was correct in the restriction, and that the type locality for *Eurycea multiplicata* (Cope) should stand as near Fort Towson, Choctaw County, Oklahoma.

The senior author and Mr. Harold A. Dundee collected the series of *multiplicata* on March 2 to 4, 1951, and the writers collected additional series on March 24 to 27, 1951. Specimens from each locality are to be deposited in the University of Kansas Museum of Natural History, the collection of H. A. Dundee, and the collection of the senior author. The field work on which this paper is based was conducted primarily for a study of the chiggers on these salamanders under a contract (N6 ori 220 Task Order 2) between the University of Kansas and the Office of Naval Research—University of Kansas, Lawrence, Kansas.

BULL SNAKE ACTIVE IN DECEMBER. — A bull snake, *Pituophis sayi sayi* (Schlegel), about 46 inches long was found DOR two and a half miles south and three miles west of Augusta, Butler County, Kansas on December 11, 1950. It appeared to have been freshly killed. This was surprising since the weather had been very cold during the preceding week when the temperature went below zero. The writer who drives a truck on the county roads most of the time believes this to be the only snake he has seen killed at this time of year. — Arnold McDowell, Augusta, Kansas, R.R.2.

The Number of Young of Xantusia

By Bayard H. Brattstrom

While working on a food study of the genus, the number of eggs and embryos found in the various species of *Xantusia* was noted.

Table 1. is a summary of the eggs and embryos found, plus those recorded in the literature by Klauber (1926, 1931) and Shaw (1949). No measurements will be given, as eggs and embryos were taken from specimens that had been in alcohol or formaldehyde for varying lengths of time.

In addition to the material in Table 1. Cowles (1944) records two young seven times and one young four times in *Xantusia vigilis;* and recently, Miller (1951) in 78 gravid females of *X. vigilis* noted one in 17 specimens, two in 60 specimens, and three in only one specimen.

It is evident from table 1 that *X. riversiana* has more young than the other species of the genus and that the form from San Nicolas Island has more young than that from San Clemente Island. This may be due to the restricted area of these islands, especially San Nicolas, which is the smaller of the two, and may be of survival value.

Xantusia arizonae

Date Collected	Number of Young	Condition
5/29/32	2	Egg-yolk only
5/29/32	2	Egg-yolk only
5/29/32	2	Egg-yolk only
5/28/39	1	Egg-yolk only
8/21/31	2	Born Dead, 8/29/31 (Klauber, '31)
8/21/31	1	Embryo-Well dev. (Klauber, '31)
8/21/31	1	Embryo-Well dev. (Klauber, '31)

Xantusia henshawi

Date Collected	Number of Young	Condition
5/21/39	2	Egg-yolk only
5/21/39	2	Egg-yolk only
7/39/28	1	Egg-yolk only
9/3 /	2	Embryos-Well dev. (Klauber, '26)
9/18/48	2	Born 9/23/48 (Shaw, '49)

Xantusia riversiana riversiana — San Nicolas Island

Date Collected	Number of Young	Condition
7/19/30	6	Embryos and yolk
7/19/30	7	Embryos and yolk
7/19/30	8	Embryos
7/19/30	9	Embryos

Xantusia riversiana reticulata — San Clemente Island

Date Collected	Number of Young	Condition
6/ /51	4	2 Embryos, 2 yolk
6/ /51	5	Embryos and yolk
7/ /50	4	Embryos and yolk
7/ /50	6	Embryos and yolk
8/16/48	5	Born 9/9-10/48 (Shaw, '49)

Xantusia vigilis

Date Collected	Number of Young	Condition
6/10/49	1	Egg-yolk only
6/12/36	1	Egg-yolk only

6/13/29	2	Egg-yolk only
6/16/38	1	Egg-yolk only
6/20/32	1	Egg-yolk only
6/25/23	1	Egg-yolk only
8/22/31	2	Embryos and yolk
8/22/31	2	Embryos fully dev.

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—San Diego Society of Natural History, San Deigo, California

HUMMING SNAKES OF NORTH AMERICA.—In November, 1950, a very large golden yellow female *Elaphe quadrivittata* (Holbrook) was allowed to rest on my hands for close inspection.. The specimen, now in the possession of Mr. V. Bohrer-Wilmersdorf, had been imported in July by the firm of Kurt Muller, Berlin-Gesundbrunnen. It had become very tame without, however, having lost its original habit of rapidly vibrating the caudal tip within a radius of 1 or 2 cm. When vibrated freely at a distance of only about 20 to 50 cm. from my ears, I became aware of a deep-toned hum, like that of a hornet, which was steadily continued until the tail tip collided with my fingers. Then the hum at once changed to the well known hissing buzz which precedes the sting of the aculeferous insect. When the snake was placed in its cage and the whole length of the tail beat the ground, the well known rattling and thrashing noises were produced.

In a quiet room the pure-toned hum may be heard at a distance of 2 to 3 yards. Although it is likely that at least all American ophidians related to *E. quadrivittata* are also humming snakes, I have not been able to find any notes in ophiological literature on this subject. As a matter of fact, the common record and knowledge of the production of mere thrashing noises undoubtedly create a prejudice quite sufficient to deafen any observer to a hum and thus prevent him from hearing any but "expected" noises. It is to be hoped that the general oversight of pure-toned sounds emitted by snakes may be rectified. I can in conclusion point out that all ophidians in any part of the world and not only those closely related to *E. quadrivittata,* may if they are seen to hold their caudal tips erect and free of the ground when vibrating them, be suspected of being able to produce a hum. I believe, however, that this humming attribute will eventually be found to be restricted to America.—F. A. T. Reuss, Barwaldstr. 4 Apt. Berlin SW 61, Germany.

Notes On Tennessee Snakes of the Genus Haldea

By Ralph Mason Sinclair

Recently two specimens of the Ground Snake *Haldea valeriae* were collected by the author. These aid in determining the ranges of the subspecies of this snake, besides furnishing data on reproduction.

The breeding habits of the Ground Snake are not well known. Published accounts give little more than size of litters, and even that is not known for the western race.

The range is also imperfectly known, especially in Tennessee. Blanchard (Papers Mich. Acad. Sci. Arts. Sci., Vol. 3, 1923. pp. 343-365) has recorded *H. v. valeriae* from Tyree Springs, northern central Tennessee, and *H. v. elegans* from Maxey, southwestern Tennessee. I am aware of no records from areas between these two localities.

A specimen of *H. v. valeriae* Baird and Girard was collected on April 3, 1948, at Radnor Lake 7.3 miles south of Nashville, Davidson County, Tennessee. It was found under a rock on a deciduously wooded hillside. A description of this specimen follows: total length 261 mm., tail length 39 mm., body width 7 mm., scale rows 15, upper labials 6-6, internasal divided, ventrals 123, caudals 30, female, anterior scales smooth becoming keeled posteriorly. Color in formaldehyde: dark grey above with four rows of small black dots. This specimen was dissected after capture, and was found to contain ovarian eggs numbering approximately 18 and ranging in length from 1 to 6 mm.

A specimen of *H. v. elegans* Kennicott was collected on May 5, 1945, at Percy Warner Park 8 miles southwest of Nashville, Davidson County, Tennessee. It was found dead on a roadside. A description of this individual is as follows: total length 238 mm., tail length 37 mm., (tip missing) body width 9 mm., scale rows 17, upper labials 6-6, internasal divided, ventrals 118, caudals 29, female, scales weakly keeled anteriorly, more strongly posteriorly. Color in formaldehyde: reddish brown with many small black dots forming four rows on the dorsum. This snake was dissected and found to contain six elongated eggs measuring from 10.5 to 12 mm. with an average length of 11.5 mm. All were 6 mm. in width.

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These two records are scarcely 4.5 miles apart yet no signs of intergradation in diagnostic characters are apparent. It is evident that the two races probably meet in the northern part of middle Tennessee. Whether intergradation actually occurs there or anywhere else, remains to be determined.

These two subspecies probably have similar breeding habits. Since the eastern one is reported to bear living young, it seems possible that the well-developed eggs observed in the *H. v. elegans* would have been retained in the body until they hatched. The presence of a very well-developed shell membrane is, however, of considerable interest as a possible indicator that at least the western subspecies may on occasion lay the eggs instead of retaining them in the body for birth. Oviparity in normally ovoviviparous snakes has not, to my knowledge, been recorded, although ovoviviparity in normally oviparous snakes (in *Opheodrys v. vernalis*) has been suggested (Blanchard, Papers Mich. Acad. Sci. Arts. Lett., Vol. 17, 1933, p. 500).

I am grateful to Dr. Hobart M. Smith for his help and advice in the preparation of this paper.

Shelby Forest State Park, Lucy, Tenn.

A TECHNIQUE FOR COLLECTING LINED UTAS, *UROSAURUS ORNATUS*. — Although utas are not especially difficult to collect, a novel method for obtaining these lizards, in a rather unusual habitat, was discovered recently. In collecting small mammals on the alluvial fans of the Huachuca Mountains, in Cochise County, Arizona, we found it necessary to check our trap line at night (usually between 10 and 11 p.m.). It was convenient to mark some traps with cotton attached to the top strand of a barbed wire fence. Where we collected at the mouth of Miller Canyon, no trees or tall shrubs were nearby. but grasses and bushes, less than knee-high, rather completely covered the sand. At night the fence was closely scrutinized by light for cotton markers. Many grasshoppers were seen on the wires and infrequently a lined uta, *Urosaurus ornatus,* was seen, motionless and with eyes closed, on the top or middle wire of the fence. The lizards held their bodies close to the fence, but their pale color made them quite conspicuous in the light. Although the utas made no effort to move while on the wire, once they were removed they ran with great speed.

Certainly these utas were in as horizontal a position as they possibly could attain and at least 300 yards from trees or shrubs taller than 2 1/2 feet. The only objects to climb would be the fence posts. It appears to me that these utas were "environmentally ill-adjusted," for in their usual habitats they prefer vertical positions and climb on trees, shrubs, or boulders. In the daytime we saw no utas in this area, although we visited it 6 times, but at night with lights we saw probably more than a half-dozen. It is believed that if a serious attempt were made to secure these lizards they could be obtained easily and in relatively large quantity by this means. — Donald F. Hoffmeister, Museum of Natural History, University of Illinois, Urbana, Illinois.

HYBRID RATTLESNAKES: — On 3/9/37 an adult male *Crotalus viridis helleri* was placed in a cage with a young female *C. ruber ruber*. Courting occurred in May of 1941 and again in February 1942. Mating took place 2/2/42, and 9 young were born on 8/11/42. (Courting was again observed in May, September and December of 1944 and June and September of 1945, also in June of 1946 but no mating.) These hybrids were a blend of the parents as far as coloration was concerned. A pair was saved but the young female died. The male, now grown, looks very much like a *scutulatus* but not the least like *helleri* or *ruber*.

On 8/28/46 a female *Crotalus durissus unicolor* was placed in a cage containing several rattlesnakes including a male *C. scutulatus scutulatus* from Arizona. No courting was observed. On 6/10/48 4 young were born, 3 males and 1 female. The young had characteristics of both parents but were more like each other in coloration than like either parent. Now (1951) the female is grayer than the more yellowish males, therein favoring her mother. Courting in these hybrids was observed in early October 1950 and mating occurred in 11/9/50. On 4/28/51 the female gave birth to 5 live young, 1 dead and 1 "bad egg." One of the young was deformed, one accidentally drowned and one died, leaving two. It is too early to tell much, but neither of the young resembles in coloration either of their grandparents, parents, or each other. The most interesting point seems to be that the hybrids were not mules. — C. B. Perkins, Zoological Society of San Diego, San Diego, California.

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Preliminary Observations On An Aggregation Of Plethodon dixi

By James A. Fowler

In June, 1946, the author visited Dixie Caverns near Salem, Roanoke County, Virginia. On this occasion, a large population of a plethodontid salamander was observed in this cave. The abundance of salamanders was particularly impressive inasmuch as this is a commercial cave. Subsequently, this salamander was described by Pope and Fowler (1949), on the basis of specimens from Dixie Caverns and adjacent New Dixie Caverns, as a new species, *Plethodon dixi*. More recently, this species has also been collected in Blankenship Cave about 2.4 miles east of Dixie Caverns.

Inside the three caves from which it has been collected, *P. dixi* is usually found near an entrance. In Dixie Caverns, where the most complete observations have been made, these salamanders are almost entirely confined to a small area in the main room of the cave above which there is an old entrance. In this small area, these salamanders are at times remarkably abundant. The maximum number thus far recorded was in June, 1949, when 322 individuals were counted. This is one of the largest aggregations of a plethodontid salamander on record, even slightly exceeding the colony of *Eurycea l. longicauda* described by Mohr (1944) from an abandoned mine in Pennsylvania.

In the main room of Dixie Caverns, these salamanders have a particular preference for a massive flowstone formation known as "the Cascades," on which they occur in great abundance, especially in the crevices between the adjoining stalactites of which this formation is comprised. Although there are other formations throughout the cave which appear to afford similar conditions—some only a few feet away, salamanders have not been observed on them. This situation seems to characterize animal aggregations generally, as pointed out by Allee (1949, p. 393) who states "Animals settle or collect in favorable localities, especially when the optimal niches are limited in extent. Often the aggregations do not occupy all the space that appears favorable."

As previously mentioned, *P. dixi* is at times remarkably abundant in Dixie Caverns. However, this population is subject to marked seasonal fluctuations. The following table, although incomplete, is indicative of these fluctuations. The figures in this table represent counts of salamanders made on single visits to Dixie Caverns during each of the months for which figures are shown. Where no figures are shown, no visits to obtain counts were made.

	Jan.	*Feb.*	*Mar.*	*Apr.*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*
1948	—	—	—	—	—	—	—	200	—	—	140	23
1949	2	1	3	0	—	322	—	—	—	—	—	—
1950	—	—	—	—	—	200	—	—	—	—	—	—

The above figures indicate that, following a period of summer abundance in the cave, the number of salamanders observed begins to decline so that by December only a few individuals are to be seen. During the winter and early spring it is difficult to find more than an occasional specimen. By the following June the salamanders are again to be found in large numbers in the cave.

What becomes of these salamanders during the winter and early spring when only scattered specimens have been found in the cave is not known. Two explanations are suggested. One is that the salamanders are still in the cave but have withdrawn into deeper recesses where they cannot be detected. The

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other is that they emigrate from the cave. This latter possibility seems unlikely in view of the outside temperatures at this season of the year, and also due to the fact that most amphibians hibernate during the winter in situations such as caves where they are protected from low temperatures. Scattered specimens have, however, been collected on the outside but only in late spring (May). The temperature in Dixie Caverns remains fairly constant throughout the year, ranging from about 52 to 54 degrees F.

Observations have been made over 24-hour periods during the summer when the greatest number of *P. dixi* are found in Dixie Caverns. These observations reveal no apparent difference between the diurnal and nocturnal activity of these salamanders. In fact, the salamanders appear to be quite inactive remaining practically motionless for long periods. Despite their apparent inactivity, it is known that these salamanders lay their eggs in Dixie Caverns. On August 19, 1948, a female attending six eggs was discovered in a crevice at the base of the formation on which these salamanders are so numerous. On this date 200 individuals were counted. In addition, these salamanders have not been observed to feed in the cave. Indeed, there are so few other organisms present that food is probably not available in the cave.

The above observations suggest that these salamanders are aestivating in the cave. Aestivation is associated ecologically with a lowered community metabolism and physiologically with a lowered organismal metabolism (Allee, loc. cit., pp. 536-537). Thus, the physical conditions on the outside in the limestone region in which Dixie Caverns is located are those conductive to aestivation; namely, relatively high temperatures and physiologically inaccessible water. In the cave, on the other hand, the temperature averages 53 degrees F. and there is a high humidity.

Finally, it is of interest to note that this aggregation of *P. dixi* in Dixie Caverns is what Allee (1927, p. 374) has termed a "homotypic aggregation," i. e., an aggregation of a single species. In fact, no other species of salamander has been found in Dixie Caverns, although several specimens of *Eurycea l. longicauda* have been collected on the outside in the vicinity of the main entrance.

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